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INFORMATION FLOW IN TRAINING EXERCISES WITH THE COMBINED ARMS TACTICAL TRAINING SIMULATOR (CATTS)

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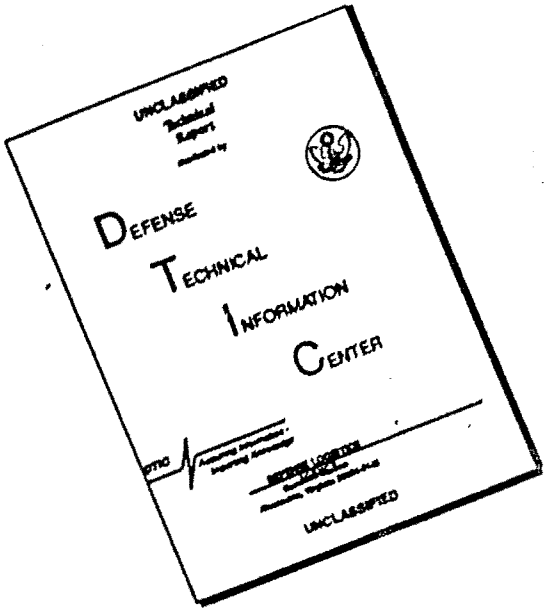

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FOREWORD

The Educational Technology and Training Simulation Technical Area of the U. S. Army Research Institute (ARI) has been concerned, in part, with evolving and evaluating alternative control systems for both unit field training exercises and command and staff training during command post exercises. The overall objective has been to develop testable concepts, evaluation techniques, and principles for applying automation, simulation, and training technology in a unit setting.

One training control system addressed within this program was the Combined Arms Tactical Training Simulator (CATTS). This report describes research on the interaction of the components of the CATTS' control system -- a computer simulation and human controllers--during training exercises conducted at Fort Benning, Georgia, for the purpose of testing the feasibility of the CATTS concept. ARI conducted this study to obtain insights about the extent to which the computer simulation served as an effective control system during these exercises.

This effort was responsive to requirements of RDTE Project 2Q763743A771, System Embedded Training Development, FY76 Work Program, and to special requirements of the CATTS Directorate, TRADOC. ARI research in this area has been conducted as an in-house effort augmented by contracts with organizations having special capabilities for specific research tasks. The present study was conducted by the ARI Fort Benning Field Unit with contractual support from the Columbus Office of the Human Resources Research Organization, Alexandria, Virginia.

SUMMARY

This document reports a study conducted by the Fort Benning Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) on the demonstration model of the Combined Arms Tactical Training Simulator (CATTS). The study was undertaken as part of ARI's research support of the CATTS Directorate during system definition research on CATTS. The overall purpose of system definition research was to develop a Training Device Requirement and user input to technical specifications for a follow-on version of CATTS. The present study was to describe the flow of information in training exercises conducted during the research period. This document presents the results, conclusions, and implications of that research.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

BACKGROUND ON CATTS

CATTS Concept

Technological advances in such areas as firepower and movement have increased a command group's capabilities for commanding and controlling the execution of tactical operations. These advances have also increased the complexity and scope of command. The Army determined that a need exists to improve through training the capabilities of a commander and his staff to conduct tactical operations on the modern battlefield. The Combined Arms Tactical Training Simulator (CATTS) was proposed as a potential means of meeting this training need. According to the CATTS concept, training personnel assisted by a computer complex would create a simulated tactical environment. This environment would require a command group to cope with stresses and problems that realistically approximate actual combat. To test the feasibility and effectiveness of the CATTS concept, a demonstration model was developed and assembled for operation at Fort Benning, Georgia, in the fourth quarter of FY 75.

The demonstration version of CATTS had three general components: a mathematical model (math model), control subsystem, and player group. The math model was designed to simulate in real time the dynamic interactions of the parameters of modern tactical operations. Through the control subsystem, the math model was to be interactive: (1) provide credible information about events simulated by it and (2) take into account decisions made by members of a command and control group. The control subsystem was composed of three elements: (1) mechanisms for receiving outputs of the math model,[1] (2) mechanisms for making inputs to the computer,[2] and (3) a set of controllers. During system definition research, the controllers served various functions. They directly interacted with the math model by receiving computer outputs and making command and control inputs. Controllers also managed enemy (red) forces and assumed the military roles of subordinate, adjacent, and higher

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1. Through the output mechanisms, computer-generated information could be obtained from the following sources during an exercise: graphics, alerts, special status reports, 15-minute summaries, or radio-teletype (RATT) messages.

2. After an exercise had been initiated, the inputs to the computer intended to influence the tactical situation are known as "command and control inputs." These were made through the use of the graphic CRT and analog graph pen and tablet.

commanders of the player's forces (blue). In terms of the latter roles, they communicated with members of a player group to provide information about the unfolding operation and to receive the players' commands, decisions, and information requests. Thus, interaction between the math model and players was mediated by the control subsystem, controllers in particular. Consequently, this subsystem appeared to be critical to the feasibility of CATTS. In the training exercises conducted with the demonstration version of CATTS, the player group was composed of a battalion commander and selected members of his staff (the S2, S3, FSCOORD, S3-Air, and ALO). The player group was located in a simulated tactical operations center (TOC). From the TOC, players communicated with controllers through communications equipment similar to that typically found in an actual TOC.[3]

System Definition Research

As originally scheduled, the demonstration version of CATTS was to undergo a six-month Operational Test I (OT I). The OT I was canceled due to apparent difficulties associated with the math model. OT I was replaced by a period of research referred to as "system definition research". The Program Director (PD) of the CATTS Directorate, located at Fort Benning, Georgia, had implementing authority for this period of research. The general purpose of the research was to exercise the CATTS system and collect data in order to (1) identify limitations and capabilities of the hardware/software (HS/SW), (2) articulate plans for use(s) of a second-generation system, and (3) provide input to technical specifications for the Training Device Requirement (TDR) for a second-generation system.

As part of system definition research, five battalion-level "command groups" underwent three training exercises. Two of the groups were incumbent command groups, one active duty and the other National Guard. The other three were ad hoc command groups assembled from various TRADOC Centers. The three training exercises consisted of two defensive operations and one attack. All were conducted in a free play mode. Prior

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3. This brief description of the system is not comprehensive. In particular, it does not cover the umpire or observer area from which tape recordings of communications were made as part of this study. For a more thorough description, the reader is referred to the Training Device Requirement (U.S. Army Infantry School. Training Device Requirement for the Combined Arms Tactical Training Simulator, Fort Benning, Georgia, March 1973) and the operator's manual for CATTS (TRW Systems Group. Operator's Manual for Combined Arms Tactical Training Simulator Device 16A3, Redondo Beach, California, June 1975).

to the start of an exercise, math model parameters were set up according to the tactical operation plans. During execution, controllers received computer outputs representing information about the developing battle. Controllers' reactions to the outputs were based on their perceptions of what would constitute realistic actions in their assumed military roles and the tactical situation modeled by the computer. Such actions included communication with members of the command group who, in turn, communicated their inputs back to the controllers. These would then be implemented by controllers, perhaps through command and control inputs to the math model. In this manner, training exercises in CATTS were to be based on the dynamic output of interaction between beginning conditions and inputs made to the math model during play, as opposed to events comprising fixed training scenarios developed at the start of exercises.

ARI'S STUDY

The present study was undertaken as part of ARI's support of system definition research. The purpose was to study the flow of information among the math model, controllers, and players during CATTS training exercises. These processes were viewed to be critical to adequate development and evaluation of CATTS. The study was designed so that issues related to controller-to-player communications and players' decisions were investigated in separate phases.

Research Concept

ARI had provided both contractual and in-house research support for Operational Test I (OT I) of CATTS. After OT I was canceled, PD CATTS indicated the need for continued research support. As plans for system definition research were near completion, it was determined that ARI's study of CATTS would be designed to collect data during the training exercises already scheduled for the overall research period.

Examination of the free-play tactical exercise approach suggested that its effectiveness would be dependent on the realism and adequacy of utilization of the math model during the exercises. To be effective, the math model needed to realistically simulate the modern battlefield at a level appropriate for training. Moreover, two characteristics of the system needed to be utilized: (1) realistic outputs of the math model needed to be communicated to players and (2) the model needed to be interactive with players. That is, the training conditions would need to create opportunitites for players to make decisions which could be communicated to and taken into account by the math model to change the modeled tactical operation. ARI's study concerned the manner in which these two characteristics were manifested in the training exercises during system definition research.

Research Objectives

The purpose of ARI's study was to describe the flow of information among the math model, controllers, and players. Controllers' communications to players were examined to determine the manner in which they were related to outputs of the math model. Players' decisions, controllers' responses to these decisions, and the feedback received by players were also investigated. More specifically, the following issues were addressed:

1. the extent to which controllers' communications were based on computer (math model) outputs.

2. the extent to which the various computer output sources were utilized by controllers.

3. whether information received by players during an exercise was based on computer outputs.

4. whether and how computer outputs were changed by controllers in communicating them to players.

5. the decisions that players communicated to controllers.

6. whether controllers enacted players' decisions by interacting with the computer.

7. whether players received feedback about their decisions.

Research Design

The study was designed and executed in three phases. The first phase involved the first two groups trained during system definition research. In this phase, controller-to-player communications (1-4 above) were addressed. Exercises for the first player group were used to pilot test observation instruments. Data on controller-to-player communications were collected during two training exercises for the second group. The second phase spanned the third and fourth player groups and addressed the issues related to players' decisions (5-7 above). Data were collected during four training exercises, two for each group. In the third phase, a questionnaire relevant to both controller-to-player communications and players' decisions was developed and administered.

In the first two phases data collection was limited to: (1) the activities of two controllers who served as forward company commanders and (2) communications of these controllers with players. In the CATTS System, there were three controller consoles, with three controllers per console. The controllers at the forward company console served as forward

company/team commanders and commanded the maneuver elements of the players' battalion. Controllers at the fire support console assumed military roles which provided artillery and fire support to the players' battalion. Controllers at the aggressor console either managed agressor forces or served as commanders of higher and adjacent units of the players' battalion. The research issues were such that data on relatively concurrent activities taking place in different parts of the system needed to be collected. Resources, however, would not permit sufficiently complete data to be collected on the activities of all controllers and players. Consequently, research was limited to those portions of a command and control system responsible for the tactical planning and execution of an operation -- players on the battalion command radio/telephone channels (the battalion commander, S3, or their representative) and forward company commanders.

For clarity of presentation in this document, methods and results will be presented separately for each of the research phases. The next section reviews the methods used to collect controller-to-player communications data and the results of this first research phase. In a subsequent section, methods and results for the issues concerning players' decisions are presented. In the last section of this document, all seven issues are discussed together.

CONTROLLER-TO-PLAYER-COMMUNICATIONS

METHOD

Training Exercises

The data on controller-to-player communications were based on two training exercises for a command group assembled from officers located at an Army career officer school. One exercise was a defense operation based on the "FEBA GOLD" scenario. The other exercise, an offense operation, was formed around the "ATTACK" scenario. Descriptions of the exercises are included in Appendix A.

During both of these exercises, activities and communications data were gathered from two controllers serving as forward company commanders. The two controllers observed during an exercise were selected on the basis of the tactical operation plan for the exercise. Accordingly, two controllers whose teams/companies were to be principal maneuver elements during an exercise (that is, forward teams during the defense or part of the attacking echelon in the attack) were selected. In both exercises, the observed controllers occupied left and right positions at the forward company console. It should be noted that the controller at the left console position was located nearest to the A/N CRT over which computer-generated alerts and special status reports were displayed. He also operated the input mechanisms for the A/N CRT and, thereby, tended to control the display of alerts and special status reports.

As originally planned, the communications of the player battalion commander (CO) and operations officer (S3) with the observed controllers were to be studied. This was to be accomplished by monitoring and recording communications over the battalion command net and designated telephone lines. During portions of the exercises, however, a radio-telephone operator (RTO) actually communicated over the radio and telephone in lieu of the CO or S3. When this occurred, the RTO's communications were monitored, recorded, and then later analyzed as if they were communications of the player CO/S3. It was assumed that the RTO was a messenger for the CO/S3 and that his communications reflected their instructions.

Observation Procedures

During the execution phase of each exercise, each controller was independently observed by a researcher. A total of three observers participated. All were experienced military officers, two active duty (03 and 05) and one retired (06). An attempt was made to distribute assignment of observers to controllers so that the same researcher did not observe the same controller in both exercises.

Two type of data were collected while directly observing controllers. One type concerned the general performances of a controller during an exercise (regardless of his assumed military role) in communicating with a player or in interacting with computer input/output mechanisms. Eight categories of performances, referred to as "activitiy patterns", were defined. They were:

1. communicating with players (other than the player CO or S3) or other controllers via radio, telephone, intercom, or face-to-face.[4]

2. communicating with the player CO or S3 by radio or telephone (referred to here as "player-to-controller communications").

3. developing or receiving RATT messages.

4. receiving or disposing of alert messages.

5. eliciting and otherwise handling special status reports.

6. acquiring information from 15-minute summaries.

7. making command and control inputs.

8. monitoring the situation (for example, viewing graphics displayed on the graphics CRT).

The second type of data was collected to facilitate later identification and content analysis of tape-recorded controller-to-player communications. For each observed controller-to-player communication, (item 2, above), the following data were recorded:

1. game time of communication.

2. communication means (radio or telephone).

3. initiator of communication.

4. whether controller provided information.

5. whether the controller sought information bearing on the communication after the communication had been initiated.

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4. This activity pattern was defined so as to exclude communications representing other activity patterns (see Appendix B).

The procedures followed by the observers in collecting the data are detailed in Appendix B. In general, an observer recorded occurence of a controller's activity patterns and the sequence of their occurrence. For each controller-to-player communication, identifying information was then recorded. Charting of the sequences of activity patterns was then resumed. This process was repeated throughout the exercises.

Controller-to-player communications were also tape recorded during the exercises using outlets in the observer area. To the extent possible, verbatim transcrips of the relevant communications were made. The transcripts were used in conjunction with the tape recordings for the content analysis. Computer printouts of alert messages and 15-minute summaries generated during the exercises were also obtained for the content analysis.[5]

Procedures For Content Analysis

The above records were content analyzed to obtain judgments relevant to the first four research issues (See p. 4). For each exercise, each controller observer independently analyzed each tape-recorded communication to the player CO/S3 in sequence of occurence. The researcher then judged who initiated the communication and whether the controller provided the player information.

When the controller had provided information to a player, the analyst performed three additional steps. First, the topics or items of information communicated were identified and listed. Second, the potential source(s) of each communicated item was identified by determining both the computer output source(s) that could have provided the information and whether the controller's activity patterns indicated that he had consulted that output source. Thus, a computer output source was judged a likely source of communicated information only if (1) the source could have provided information like that communicated to the player and (2) the controller had consulted the source prior to the communication. The third step identified transformations of computer outputs, defined as differences between the information displayed in the relevant computer outputs and in information communicated to a player. In order to identify differences, the analyst assumed that the sources, which appeared to have provided an item of information to the controller, had actually done so. He then judged whether one or more of the following had occurred:

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5. Input mechanisms for the A/N CRT allowed printing of special status reports as they were elicited during an exercise. It was not possible, however, to print status reports because the time required to do so would have interferred with the timely receipt of alert messages.

1. form alteration -- the information communicated to the player was essentially the same in denotative meaning as the output(s); however, it was expressed in a different manner or form.

2. alteration of detail -- the information in the communication was not at the same level of detail as that in the computer output(s).

3. deletion of information -- the computer output(s) consulted by the controller provided information about parameters not transmitted to the player.

4. addition of information -- the output(s) consulted by the controller provided the types of information communicated to the player; however, the controller added information about variables not represented in the output(s).

Certain features of the procedures just described should be underscored. The first concerns the meaning of the judgments made about the output sources. Such judgments do not imply that information communicated to the player was an exact replication of the information provided by the related output source. Rather, the judgement was that the communication was probably based on that source. Transformations of outputs were investigated partly because of anticipated elaborations and changes that typically occur when parties relay information. Second, in a communication, more than one topic or item of information was often communicated. Third, information provided by the output sources was not mutually exclusive so that more than one output source was often attributed to a communication. Likewise, it was possible for more than one transformation to be reflected in a given communication.[6]

6. As two individuals had independently analyzed each recorded communication, procedures were needed to resolve conflicting judgments. Accordingly, one analyst reviewed the judgments of both in conjunction with the recorded material and resolved conflicts in those data to be further analyzed and reported here. Four steps were involved in the conflict resolution: First, it was necessary to insure that the judgments of each analyst were based on the same communications. Entries on the content-analysis forms (that is, data sheets) referencing the game times of communications were checked. When discrepancies were found, the content of communications (that is, the subjects or items communicated) were used to match the forms of the two analysts. Second, discrepancies between judgments about the sources of communication were resolved by consulting observation data on activity patterns and comparing the content of a communication with the actual (alerts) or likely (graphics and special status reports) content of computer outputs. Third, differences in the descriptions of items of information communicated to players were arbitrarily resolved by the reviewer. Fourth, conflicts of judgments about transformations were resolved by reviewing the tape recorded communications.

The variables about which judgments were made in the content analysis are defined more completely in Appendix B. The procedural guidelines and content-analysis forms used by the analysts are also presented there.

Controller Questionnaire

Approximately 10 days after the last training exercise, controllers were administered a semi-structured questionnaire to obtain their opinions as a supplement to the direct observation and content-analysis data. The questionnaire was developed by ARI after all observational data reported in this document had been collected. Each controller responded to the questionnaire at his own pace after having its purpose explained by a researcher. Eleven of 12 controllers responded in time for this report.

The questionnaire is presented in Appendix C. Descriptions of the 11 respondents are also provided. Responses to those questionnaire items which directly bear on the research issues are presented in the body of this document. Responses to all items are included in the appendix.

RESULTS

The results of controller-to-player communications are presented by related research issues. The time available for planning and executing the research did not afford the opportunity to pretest data-collection instruments or to conduct reliability checks to the extent desirable. Consequently, the patterns of data are probably more meaningful than the exact numbers presented.

Communication and Related Output Sources

The first research issue concerned the extent to which controllers' communications to players were based on outputs of the computer (math model). The data most directly pertinent to this issue were obtained from the content analysis of player-to-controller communications. Each controller communication of information to players was examined as described earlier. Table 1 presents the frequency and proportions of communications judged to have been based on information from the various combination of computer-output sources. This table indicates that 98% of the communications were judged to have been based on one or more outputs of the computer.

Table 1

Frequency & Proportion of Communications

Based on Output Sources: Content Analysis

Output Sources	Exercise		Total
	Defense[a]	Attack[a]	
Graphics(G)	28 / .46	20 / .29	48 / .37
Alert (A)	1 / .02	5 / .08	6 / .05
Special Status Report(R)	7 / .11	0 / .00	7 / .05
G & A	4 / .07	21 / .30	25 / .19
G & S	15 / .25	9 / .13	24 / .18
A & S	0 / .00	1 / .01	1 / .01
A & G & S	4 / .07	12 / .17	16 / .12
Fabrication	2 / .03	1 / .01	3 / .02
Total	61 / 1.00	69 / 1.00	130 / 1.00

[a] Data are based on one training group. Top number in a cell represents the frequency of communications, bottom number the proportion.

During the exercises, observation records were maintained of the instances in which a controller sought information while he was communicating with a player. The observers recorded 162 communications across the two exercises.[7] Records indicate that controllers sought information during 121 of the 162 communications. Table B-1 in Appendix B shows that controllers sought information from seven sources of information. In this table, it appears that for the 121 communications, controllers consulted a total 186 sources. Of these 186 instances, 148 involved consultation with a computer-output source.

Several items in the controller questionnaire concerned the first issue. In response to item 43, controllers were to estimate the extent to which feedback to players decisions was based on computer outputs. Responses (medians) of controllers at the forward company console indicated that .40 of the feedback was completely based on computer outputs and that .50 feedback was based on a combination of computer-generated and fabricated information. Two items (27 and 54) directly addressed whether controllers had provided players information that either conflicted with or was not provided by outputs of the computer. In responding to these items, several controllers acknowledged that they had deviated from math model outputs. The reasons cited for doing so appear to fall into one of two general categories: (1) the desire to create a realistic atmosphere and (2) areas of inaccuracy and incompleteness in the math model. In the responses to several items (see items 6 and 27, Appendix C, as examples), consistent references were made to one area in which the model is inadequate: weapons and their effects.

In summary, the findings relevant to the first research issue suggest that information communicated to players during training exercises tended to be based on outputs of the math model (p = .90). Responses to the questionnaire seem to indicate that controllers supplemented or otherwise manipulated computer-generated information prior to communicating it. The latter is more thoroughly addressed as part of the issue on transformations.

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7. This number is higher than the 130 communications extracted from the tape recordings. The difference probably reflects two main sources of error. First, observers were likely to have recorded information about communications made by controllers in roles other than forward company commander. Second, there were gaps in the tape recordings. A principal reason for emphasizing the results of the content-analysis is that the tape-recorded communications were available for repeated analysis.

Utilization of Computer Outputs

The second research issue concerned the utilization of computer outputs. Both the content analysis and the activity patterns bear on this issue. These data are supported and supplemented by controllers' responses to the questionnaire.

Table 1 displays the frequency and proportion of communications judged to have been based on computer-outputs. Data in the table suggest the following:

1. Information provided by graphics appears to have been represented in communications to players more frequently than information provided by any other output source.

2. The tendency for communications to be based on graphics alone was greater in the defense than in the attack.

3. The second most frequent source of communicated information appears to have been special status reports for the defense and alert messages for the attack exercise.

4. No communication was based on a 15-minute summary.

Tables 2 and 3 display, for the defense and attack respectively, the frequency of communications providing information judged to be based on the various output sources. In the two tables, communications are further sorted in terms of, first, the initiator of the communication (that is, the observed controller or the player CO/S3) and, second, the controllers' positions at the company controllers' console. Data presented in these two tables tend to indicate the following:

1. In both exercises, communications of the controller at the left console position appeared to convey information from special status reports more frequently than communications of the controller at the right console position.

2. Compared to the attack, a greater frequency of communications in the defense appears to have been intiated by players.

As described earlier, two steps were taken to determine the output sources on which a communication was based. The items of information communicated to players were first extracted. The potential output source(s) of each communicated item was then identified. Tables 4 and 5 display findings for items of information (as opposed to those for communications as a whole presented in Tables 1-3). Table 4 presents the frequency and proportion of all items communicated to players judged to be based on the various output sources. Certain information items (for

Table 2

Initiation of Communications During Defense Exercise: Content Analysis[a]

Sources Consulted	Controller Position				TOTAL
	Left		Right		
	Controller Initiated	Player Initiated	Controller Initiated	Player Initiated	
Graphics(G)	3	12	7	6	28
Alert(A)	0	0	1	0	1
Special Status Report(S)	2	2	2	1	7
G & A	1	1	2	0	4
G & S	7	6	2	0	15
A & S	0	0	0	0	0
A & G & S	0	1	1	2	4
Fabrication	0	2	0	0	2
Total	13	24	15	9	61

[a]Data are based on one training group. They represent the frequency of communications that were initiated by a player or the controller and that contained information judged to be based on the various output sources.

Table 3

Initiation of Communications During Attack

Exercise: Content Analysis[a]

Sources Consulted	Controller Position				TOTAL
	Left		Right		
	Controller Initiated	Player Initiated	Controller Initiated	Player Initiated	
Graphics(G)	12	3	2	3	20
Alert(A)	1	0	3	1	5
Special Status Report(S)	0	0	0	0	0
G & A	6	5	10	0	21
G & S	5	2	2	0	9
A & S	0	0	1	0	1
A & G & S	7	5	0	0	12
Fabrication	0	1	0	0	1
Total	31	16	18	4	69

[a]Data are based on one training group. They represent the frequency of communications that were initiated by a player or controller and that contained information judged to be based on the various output sources.

Table 4

Frequency & Proportion of Information Items Based on Output Sources: Content Analysis

Sources Consulted	Exercise		Total
	Defense[a]	Attack[a]	
Graphics	32 / .44	42 / .36	74 / .39
Alert(A)	1 / .01	7 / .06	8 / .04
Special Status Report(S)	6 / .08	1 / .01	7 / .04
G & A	4 / .06	37 / .31	41 / .22
G & S	22 / .31	11 / .09	33 / .17
A & S	0 / .00	2 / .02	2 / .01
A & G & S	5 / .07	17 / .14	22 / .12
Fabrication	2 / .03	1 / .01	3 / .01
Total	72 / 1.00	118 / 1.00	190 / 1.00

[a]Data are based on one training group. Top number in a cell represents frequency, bottom number proportion.

Table 5

Frequency of Separate Information Items

Based on Output Sources: Content Analysis

Sources Consulted	Exercise		Total
	Defense[a]	Attack[a]	
Graphics (GS)	14	14	28
Alert (A)	1	5	6
Special Status Report(S)	5	1	6
G & A	4	12	16
G & S	10	6	16
A & S	0	2	2
A & G & S	5	3	8
Fabrication	2	1	3
Total	41	44	85

[a]Data are based on one training group.

example, information about the locations of units) appeared in more than one communication, and each occurence of an item is reflected in the figures in Table 4. Table 5 displays the frequency of separate items communicated by controllers;[8] thus, this table tends to demonstrate the variety of different subjects based on the combinations of output sources. The data in both tables display the trends observed for frequency of whole communications.

The items of information extracted from the communications are summarized in Tables B-2, B-3, B-4, and B-5 in Appendix B. Items are listed according to the output source(s) that potentially provided the controller information about them. Inspection of these tables suggests that graphics were especially used by controllers to obtain information relevant to fires (artillery and air) and location/movement. Information items based on special status reports appear to have referred to a unit's strength and status. Communications based on alerts appeared to concern the status of units, losses, strength, and disposition.

The frequency and proportion of each controller's activity patterns observed in training exercises are displayed in Table 6. "Monitor the situation" was the most frequently observed activity pattern. This activity pattern included instances in which the controller appeared to be obtaining information from the graphics CRT. Assuming that such instances comprised a major proportion of performance classified as "monitor the situation", these findings further suggest the importance of graphics as a source of information for controllers. Differences between controllers located at the different console positions are also of interest. In particular, the controller at the left console position shifted activity patterns more frequently than the controller at the right position. The cause of this difference is not readily apparent. There was essentially no difference between the two controllers in proportion of "alert message" activity patterns. Compared to the right controller, however, a greater proportion of the left controller's activities was associated with the use of "special status reports." These findings for alert messages and special status reports are of special interest since the left controller operated the input/output controls for these two sources of information.

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8. The separate subjects for each controller were combined to form Table 5. Thus, the figures in Table 5 are inflated by those items which both controllers communicated.

Table 6

Frequency & Proportion of Activity

Patterns During Exercises: Observation Data

Exercise	Controller Position	ACTIVITY PATTERN[a]								Total
		M	C	A	Sb	Sr	R	15	CC	
Defense	Left	180 / .35	152 / .30	66 / .13	35 / .07	61 / .12	1 / .00	0 / 0	16 / .03	511
	Right	75 / .39	69 / .36	23 / .12	18 / .09	0 / .00	0 / .00	0 / .00	6 / .03	191
	Total	255 / .36	221 / .31	89 / .13	53 / .08	61 / .09	1 / .00	0 / .00	22 / .03	702
Attack	Left	208 / .36	121 / .21	144 / .25	59 / .10	28 / .05	0 / .00	0 / .00	24 / .04	584
	Right	99 / .41	53 / .22	62 / .25	12 / .05	10 / .04	0 / .00	0 / .00	8 / .03	244
	Total	307 / .37	174 / .21	206 / .25	71 / .09	38 / .05	0 / .00	0 / .00	32 / .04	828
TOTAL		562 / .37	395 / .26	295 / .19	124 / .08	99 / .06	1 / .00	0 / .00	54 / .04	1530

[a]The activity patterns were"monitor the situation" (M), "communicate with player/controller other than CO or S3" (C), "alert message" (A), "special status report for blue unit" (Sb), "special status report for red unit" (Sr), "RATT message" (R), "15-minute summary" (15), and "command and control input" (CC).

The questionnaire was constructed to obtain three general categories of data about the utilization of computer-output sources: (a) estimates of the relative utilization of the output sources, (b) types of information obtained from the three principal sources (graphics, alerts, and special status reports), and (c) problems associated with their use. Responses concerning the relative use of output sources are presented first. Responses to other items are organized according to output source.

In response to item 5, each controller ranked six sources in terms of the extent to which he obtained information from them during a training exercise. The median ranking of the respondents who had served as controllers at the forward company console was as follows, from most to least frequently used: graphics, alerts and special status reports (tied), other controller, RATT messages, and 15-minute summaries. This order is congruent with results reported earlier.

Several questionnaire items concerned graphics (items 1, 8, 17, 19, 20, and 23). Item 1 investigated controllers' perceptions of their use of graphics information. It asked for ratings of 73 items of information presented through graphics in terms of the following: (a) the frequency with which a controller used each item of information, (b) the importance of the item to the controller, and (c) the extent to which the item was reflected in his communications to players. For each item listed, the median rating for controllers at each console (forward company, fire support, or aggressor console) was calculated. These ratings are presented in Appendix D. The median ratings of the controllers at the forward company console for the three questions were correlated across the 73 items using the Spearman rank-order correlation coefficient. The correlation coefficients were as follows: (a) .91 of frequency of use with perceived importance, (b) .83 frequency of use with frequency reported to players, (c) .75 perceived importance and frequency reported to players. All coefficients were positive and statistically significant ($p < .05$). Responses were also analyzed for differences between the ratings for red and blue graphical items. That is, the list (see Appendix C) was composed of 37 different items; 36 of which were presented twice, once as information about own (blue) forces and once as information about opposing (red) forces. For each question, median responses to all red and all blue items were computed. As would be expected, the items of information about own forces were rated more important (Md = 3.0) than information about opposing forces (Md = 1.3). Similarly, controllers' responses suggest that graphical information about own forces tended to be reported to players (Md = 1.0) more frequently than graphical information about red forces (Md = .3). Controllers' ratings for frequency of use were slightly higher for information about own forces (Md = 1.4) than for information about opposing forces Md = 1.0).

Items 17-20 and 23 concerned problems associated with the use of graphical information and the graphics CRT. The types of problems most frequently cited suggest that the graphics CRT was a valuable control mechanism and that there was competition for its use. In item 20, for example, controllers were presented a list of difficulties potentially associated with the use of computer-generated information. At least two of the three respondents from the forward company console endorsed the following:

1. Delay in locating information on the graphics CRT because the map scale was too large.

2. Delay in locating information on the graphics CRT because the map scale was too small.

3. Delay in locating information on the graphics CRT until the proportion of the map being displayed could be changed.

4. Display of graphic information blocked by command and control menu options.

5. Delay in locating graphic information because the center controller was involved in other duties.

All three controllers described the fifth problem as significant.

Of the questionnaire items concerned with alerts, responses to items 2, 17, 18, 19, and 23 are most pertinent here. Item 2 presented controllers with a list of 30 alert messages that could have appeared on the A/N CRT during a training exercise. Each message was rated by a controller as to (1) the extent to which he used the alert, (2) the importance of the information to him in his role as a controller, and (3) the extent to which the information was reflected in his communications to players. Responses to this item were scored as they were for item 1. (Appendix D contains the median ratings of controllers.) For controllers at the forward company console, the median ratings of frequency of use, importance, and frequency reported to players were correlated across the 30 items. The Spearman rank-order correlation coefficients were as follows: (a) .90 for frequency of use with importance, (b) .91 for frequency of use with frequency reported, and (c) .87 for importance with frequency reported. All three coeffieicents were statistically significant.

Controllers' responses to items 17, 18, and 19 indicated several problems associated with the use of alert messages. Problems cited were grouped into three general areas. One area pertains to the timing of the receipt of alerts. This area includes the complaint that information from

alerts was not always available when needed.[9] Problems involved in clearing alerts from the A/N CRT were also mentioned. A second problem area concerns the formatting of alerts, or the manner in which they were presented. Two controllers indicated that alert messages were difficult to read and need to be restructured. The third area consists of the types of information presented through alerts. It appears that alerts routed to a console did not provide all information desired by controllers located there. Areas in which one or more controllers believed alerts to be deficient included (a) casualty reports, (b) current unit status as a result of casualties, (c) shell reports, and (d) reports on the ammunition levels of units.

Items 3 and 4 of the questionnaire asked controllers to list the categories of information that they sought from special reports for blue and red units. Each respondent formed his own categories from the types of information presented in special status reports: unit location; movement rate; unit elevation; status of personnel; status of equipment; status of ammunition; and status of fuel. Respondents from the forward company console most frequently used special status reports to obtain information about the status of personnel and equipment. All three controllers, however, sought all types of information to some extent, with the exception of unit location and elevation. Each of the latter was used by only one controller. A similar pattern was obtained for special status reports about red units with two exceptions. First, special status reports were used to obtain information about the movement rates of red units. Second, no controller sought information about fuel. Item 13 elicited similar responses.

Items 17, 18, and 19 queried problems encountered in using the special status report. A large number of respondents to these items reported no difficulty in using special status reports. From the responses of other controllers, however, two general categories of problems were identified. One category pertains to information presented in special status reports. This category included complaints by one or more respondent about (a) the format of the special status report, (b) the types of information presented, and (c) the amount and detail of information in special status reports. The second category consists of problems related to output

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9. The controllers had to dispose of alert messages once they appeared on the A/N CRT. One means was to clear or drop the alerts from display. A message would remain on display (thereby, possibly blocking receipt of more current alerts) until it was disposed of.

mechanism. For example, it was time consuming to accomplish any of the following: (a) request a single special report, (b) print a special status report, or (c) request a series of special status reports. The multiple functions of the A/N CRT appear to have contributed to these and other problems. Based on responses to item 17, for example, requesting a series of special status reports was time consuming due to the display of alert messages between each successive status report in the series. RATT messages, which appeared on the A/N CRT, also pre-empted special status reports. The second category included other responses suggesting that the method for requesting special status reports could be simplified or made less error prone.

Item 20 also elicited descriptions of four potential problem areas related to the use of special status reports. Of the three controllers from the forward company console, two reported two problems: (a) delays in requesting a special status report because the A/N CRT was being used for another function; and (b) delays in obtaining a special status report because the operator of the A/N CRT had other duties to attend to. These responses further suggest that the multiple functions of the A/N CRT created difficulties in interacting with the math model.

Questionnaire item 23 asked about graphics, alerts, and special status reports. Controllers were questioned about a need for additional output devices. Of 12 respondents, eight responded affirmatively. In describing the needed device(s), most of the controllers were unfortunately vague. For example, five described the needed device as a "CRT" for each controller, without specifying whether the need was for a graphics CRT or for an A/N CRT. Thus, the responses to item 12 suggest a general need for additional output devices; however, definitive responses about this need were not obtained.

As mentioned earlier, no controller-to-player communication was judged to have been based on a 15-minute summary. Throughout the observation period, no controller was observed to consult a 15-minute summary for the purpose of controlling a training exercise (see Table 6 on the activity patterns). Controllers were also asked to described their use of the 15-minute summary during training exercises and their reasons for not having used the summary more often. Only one controller reported that he had ever used the 15-minute summary; he indicated that he had used it during two of the five training exercises conducted during system definition research. Seven controllers provided reasons for not using the 15-minute summary. One set of reasons was associated with time. That is, several controllers reported that required analysis of a 15-minute summary for relevant information was too time consuming. Two controllers also reported that information in the 15-minute summary was untimely. A second set of responses was perhaps implied by those just presented. These suggested that use of the 15-minute summary was limited because of the difficulty of reading and understanding it. The third set of responses

concerned the value of information contained in the 15-minute summary. That is, three respondents indicated that the information was not needed. In general, then, the 15-minute summary was not used because the information in it was not perceived to be valuable enough to ignore other responsibilities and to exert the effort required to make use of it given the time constraints.

In summary, these data indicate that graphics, alert messages, and special status reports were the more frequently used sources during an exercise. Alone, or in combination with other sources, graphics were the single most frequently used source. Information communicated to players was largely based on these output sources as well. The use of these three outputs tended to be complicated by certain problems. In terms of graphics, responses to the questionnaire suggest that there were delays in obtaining the information desired by an individual controller. The delays appear to be related to competing demands on (or multiple functions of) the graphics CRT and its operator. There were at least three types of problems associated with the use of alerts. These pertained to time, the availability of desired information, and the ease with which information presented through alerts could be read and understoond. Certain characteristics of the output mechanisms also affected the use of special status reports. Finally, results indicated that 15-minute summaries were neither used nor useful by controllers in the training exercises during system definition research.

Player Requested Information

The third issue -- concerning whether information requested (and received) by players was based on outputs of the computer -- was not systematically addressed. Taken together, however, various data suggest the likelihood that information requested by players was based on computer outputs.

Table 7 is based on the 162 communications directly observed. It displays the frequency and proportion of controllers' communications of information to players. This table shows that controllers provided information in approximately .80 of their communications to players. As presented in Table 1, .98 of the observed controllers' communications were judged to have been based on computer-output sources consulted by controllers. The data displayed in Table 7 also suggest the possibility of differences between the defense and attack exercises. Compared to communications in the attack, a greater proportion of the communications initiated by players in the defensive exercise appeared to be associated with a controller's providing information about the tactical situation.

Impressions about controllers' feedback to players' decisions are also relevant. As part of the analysis of players' decisions, judgments were made as to whether the feedback had been provided by the controller without the players' requesting it. The analysts then estimated whether the

Table 7

Initiation of Information Communications:

Observation Data[a]

Exercise	Controller Position	Initiator of Communication	Controller Provided Information		Total
			Yes	No	
Defense*	Left	Player	20 .68	10 .33	30
		Controller	12 .86	2 .14	14
	Right	Player	10 .67	5 .33	15
		Controller	20 1.00	0 .00	20
Attack*	Left	Player	10 .53	9 .47	19
		Controller	37 1.00	0 .00	37
	Right	Player	7 .54	6 .64	13
		Controller	14 1.00	0 .00	14
Defense	Left & Right	Player	30 .68	15 .33	45
		Controller	32 .94	2 .06	34
Attack	Left & Right	Player	17 .53	15 .47	32
		Controller	51 1.00	0 .00	51
Total Player Initiated			47 .61	30 .39	77
Total Controller Initiated			83 .98	2 .02	85
Total			130 .80	32 .20	162

[a]Data are based on one training group for each of the defense and attack. They represent the frequency and proportion of communications (a) in which the controller did/did not provide information and (b) which were initiated by either a player or controller.

feedback could have been based on computer-generated information. The analysts' overall estimate was that requested as well as automatically provided feedback could have been formed from outputs of the computer. This impression is compatible with the forward company controllers' responses to questionnaire item 43; more specifically, they reported .90 of the feedback was based on either computer outputs alone or a combination of computer-generated and fabricated information.

Three other questionnaire items are relevant to the third issue. As part of item 15, controllers were asked whether two types of information communicated to players were based on computer outputs to the same degree: information communicated at the controllers' own instigation and information reqested by players. Only three of the 10 respondents believed that there was a difference. Responses of two respondents indicate information requested by players more closely approximated computer outputs. That is, these two reported that requested information was less embellished for purposes of realism; it conveyed less of the "human elements", panic, and pressure of the battlefield. In response to item 7, four of 11 controllers reported that the computer failed to provide player-requested information. Respondents from the forward company and fire support consoles noted two types of information: reasons why a unit was stopped and information related to weapons and their effects. Of 10 respondents, four reported that there were occasional delays in communicating information requested by players. Reasons cited for delays were: (a) system failures, (b) hardware unavailability, and (c) need to combine items of information in order to provide the appropriate response.

In summary, .98 of the communications were judged to have been based on computer outputs. Observers' impressions and controllers' reports suggest that most of the feedback to players' decisions was based on computer-generated information. Based on these findings, it is likely that information requested by players, as well as information automatically provided by controllers, was based on computer-generated information. Moreover, responses to one questionnaire item (number 15) suggest that when requested information was available through computer-generated outputs, this information may have been more directly communicated.

Transformation of Outputs

The fourth issue concerned ways in which controllers transformed computer outputs in communicating them to players. Data bearing on this issue were collected through the content analysis of communications and controllers' responnes to the questionnaire.

As part of the content analysis, judgments were made about the output source(s) of each item of information communicated to players. To identify transformations, the analysts assumed that the information items judged to be based on one or more sources had actually been based on that source.

Information items as communicated to players were then compared to outputs that controllers would have received through the source. In making the comparisons, analysts determined which of the following transformations were represented in a communication: (a) form alteration, (b) alteration of detail, (c) deletion of information and (d) addition of information.

Table 8 displays the frequency of communications with information items judged to exhibit one or more of the four types of transformations. This table reveals that all 130 communications extracted from the tape recordings involved one or more type of transformation. The most frequently identified transformation was alteration of form. As presented earlier, "alteration of form" involved changes in the manner or form of expressing information provided by computer outputs without changes in denotative meanings. According to this definition, all communications based on graphics would have exhibited alteration of form. Thus, it is likely that the frequency of form alteration was largely accounted for by the frequent use of graphics as an informations source. Two other transformations were identified by the analysts: alteration of detail and addition of information. In combination with alteration of form, each of these transformations was found in over .25 of the communications. These findings imply that controllers often (1) altered the specificity of computer outputs (alteration of detail), and (2) communicated information related to computer outputs but not actually conveyed in the outputs themselves. Tables B-6, B-7, B-8, and B-9 in Appendix B summarize the information items judged to exhibit the combinations of alterations. No relationship between type of information and type of transformation is readily apparent.

No communication was judged to exhibit deletion of information, that is, withholding information from the computer outputs on which a communication was based. This finding is incongruent with impressions formed from direct observation of controllers performances,[10] and it appears to suggest that the transformation type could not meaningfully be applied during the content analysis. For this reason, the transformations were revised in constructing the questionnaire.

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10. That is, through outputs of the math model, controllers had access to a wealth of detailed information about the tactical situation. It was obvious that, given the constraints on and nature of training, controllers were unable to transmit all information to players.

Table 8

Frequency of Transformations:

Content Analysis[a]

Transformation	Defense		Attack		TOTAL
	Controller Position		Controller Position		
	Left	Right	Left	Right	
Form	12	14	27	10	63
Detail	0	0	1	0	1
Deletion	0	0	0	0	0
Addition	3	1	0	1	5
Form/ Detail	12	7	10	2	31
Form/ Deletion	0	0	0	0	0
Form/ Addition	8	2	7	7	24
Detail/ Deletion	0	0	0	0	0
Detail/ Addition	0	0	0	0	0
Deletion/ Addition	0	0	0	0	0
Form/Detail Addition	2	0	2	2	6
TOTAL	37	24	47	22	130

[a]Data are based on one training group for each of the defense and attack. Numbers represent the frequency of communications judged to contain information items manifesting one or more transformation.

Item 16 was directly concerned with the transformation of computer outputs. Each controller was asked to rank three types of transformations in terms of the frequency with which he made them during a training exercise and to describe the reasons for making them. The three transformations rank-ordered by the controllers were as follows:[11]

1. addition -- the communication contained a greater amount of (or more detailed) information than was contained in relevant computer outputs.

2. different information -- information provided in a comunication was inaccurate compared to available computer outputs.

3. reduction -- the communication contained a lesser amount of (or less detailed) information than was contained in relevant computer outputs.

For the controller having served at the forward company console, the median ordering of frequency of occurence was as follows (from most to least frequent): reduction, addition, and different information. Thus, the forward company controllers believed that they most frequently transformed computer outputs by reducing the amount or specificity of information reflected in them. All of the responding controllers (n = 8) cited "realism" as the reason for reducing information. Respondents expressed the belief that information reflected in computer outputs tended to be too detailed or complete to communicate to players in the context of a realistic battle. Four reasons appear to have prompted controllers to add information: six respondents cited "realism"; one controller was prompted by math model "inaccuracies"; three controllers added information to compensate for areas of "incompleteness" in the math model; finally, two controllers made this transformation during system failures, that is, when the model was not providing current information. Similar reasons were cited for communicating information that differed from information conveyed by math model outputs. "Inaccuracy" and "incompleteness" of the math model were cited by three respondents. "Realism" prompted this transformation for two controllers.

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11. In defining the categories, it was recognized that they were not mutually exclusive. Alteration of form was excluded because of its already apparent prevalence.

In summary, the content analysis suggests that controllers tended to transform information reflected in computer outputs prior to communicating it to players. Alteration of form was the most frequent type of transformation. In addition, controllers often (1) altered the specificity of computer outputs and (2) communicated information related to computer outputs but not actually conveyed in the outputs themselves. Forward company controllers suggested that reduction was the type of transformation made most frequently, followed by the addition of information and the communication of different information. Controllers cited the following reasons for transforming outputs: (1) to promote realism, (2) to compensate for areas of incompleteness and inaccuracy in the math model, and (3) to provide information during period of system failures.

PLAYERS' DECISIONS

METHOD

Training Exercises

The last three research issues were investigated during two training groups. For each group, data were collected on performances during the defense and offense exercises based on the FEBA GOLD and ATTACK scenarios, respectively. The command group of an active-duty mechanized infantry battalion participated as the player group in the exercises that are labelled "Defense-1" and "Attack-1" in later sections of the report. The player group in "Defense-2" and "Attack-2" consisted of the commander and staff of a mechanized infantry battalion of the National Guard. More complete descriptions of the exercises are included in Appendix A.

As in the research on player-to-controller communications, data were collected on a sample of the participants. In each exercise, the activities and communications of two controllers serving as forward company controllers were included. These were selected in the manner described for controller-to-player communications. In three of the exercises, the observed controllers occupied the left and right positions at the forward company console. In Attack-1, the observed controllers occupied the left and center console positions. The controller at the center position served as the operator of input mechanisms for both the display of graphical information and the entry of command and control inputs. As originally planned, decisions communicated to the two forward company controllers by the player commander (CO) and operations officer (S3) were studied. As discussed for player-to-controller communications, many of the decisions included in the study were actually communicated by a radio-telephone operator (RTO).

Observation Procedures

During each exercise, each controller was independently observed. The same three observers served as data collectors for this part of the study. Observers were assigned to controllers so that the same researcher did not observe the same controller in all exercises.

During an exercise, each observer focused on two general sets of activities of a controller. The first set consisted of the controller's communications with the player CO/S3 over the battalion command net and designated telephone lines. The observer was to identify the decisions which the player CO/S3 communicated to the controller in his role as forward company commander. The second set involved the command and control inputs that were made for units modeled by the computer and under the authority of the observed company commander. By focusing on these two sets of activities, the observer identified the following:

1. game times and summaries of decisions communicated from the player CO/S3 to the controller.

2. controller's response to a decision.

3. game time and type of each command and control input made for units represented in the math model and under the authority of the forward company commander.

4. source of a command and control input, that is, the individual in the system (player, observed forward company controller, or operator of the command and control input mechanisms) that appeared to initiate the input.

Appendix D contains the instructions followed by observers in collecting the data. The types of data collected are more completely described as well.

Two other records were obtained for use in the content analysis described later. First, communications between the forward company controller and the player CO/S3 (or the RTO where necessary) were recorded. Second, computer records of command and control inputs entered at all four consoles were also obtained and later analyzed.

Procedures for Content Analysis

The tape-recorded communications were analyzed to document decision making during CATTS training exercises. Computer records of command and control inputs were then reviewed to determine whether the decisions had been implemented through command and control inputs.

Analysis of communications. Two observers jointly analyzed the tape-recorded (and transcribed) communications in conjunction with data records made while the exercise were observed. In analyzing the communications, the researchers made judgments about players' decisions, a controller's response to a decision, and feedback.

The research procedures and variables studied are defined more completely in Appendix D. In general, the two researchers reviewed the communications between players and a forward company controller to identify decisions that players (the CO/S3 or the RTO) communicated to the controller. A decision was defined as the expression of an intention that actions are to be taken or that some objective, purpose, or mission is to be achieved.

For each decision, four types of data were collected. First, the game time and substance of the decision were summarized. Second, observation records were consulted to determine whether the decision had been identified when the communications were directly monitored during the exercise. If the decision had been identified during the exercise, data on

the observation record were used to determine if the decision had been carried out by the controller by making one or more command and control input to the computer. If the decision had not been identified during the exercise, judgments were made as to whether the decision could have been implemented through command and control inputs, that is, whether actions implied by the decision could be enacted through the command and control inputs available to a controller. Third, judgments about conditions prompting the decision were made. In particular, judgments were made as to whether the decision (a) had been directly prompted by conditions or problems communicated to the players by the forward company controller or (b) represented a response to general or long-term developments that may or may not have been reported to the players. Finally, the controller's feedback to the decision was identified. For purposes of the content analysis, feedback was defined as information communicated to the players by a controller regarding the implementation of a decision. The game time and substance of each communication which conveyed feedback were summarized. Judgments were also made as to whether the feedback had been automatically provided by the controller, requested by the player, or both.

After all decisions had been analyzed, a researcher (not an observer during the exercises) reviewed the summaries of the decisions and feedback identified by the first two analysts. The third reviewer's disagreements with the summaries were resolved between him and one of the original analysts.

Analysis of computer records. As described earlier, observers were to identify each command and control input made for units under the authority of the observed forward company controllers. Originally, computer records of command and control inputs were to be analyzed to check the reliability of the corresponding observational data. Due to preliminary findings, the records were also used to identify command and control inputs made in response to players' decisions.

The computer records of command and control inputs provided a variety of uncollated data describing command and control inputs made during an exercise. Four items were used to identify and record the command and control input made for units under the authority of an observed forward company commander: the time of an input, the type of command and control input, entries designating the unit(s) affected by the input, and controller console from which input was entered. These inputs were further analyzed to identify and record the game time and type of each command and control input for units under the authority of the observed forward company controllers.

When the command and control inputs extracted from the computer records were compared with the supposedly corresponding data collected by observers during the exercises, relatively large differences were found. It was especially evident, for example, that observational data grossly underestimated the frequency with which command and control inputs had been made. This raised the possibility that data on the implementation of

decisions through command and control inputs were unreliable. Consequently, the command and control inputs extracted from the computer records were further analyzed in relationship to players' decisions.

Two researchers[12] jointly analyzed the command and control inputs extracted from the computer records in conjunction with the decisions that had been summarized from the tape-recorded communications. As implied earlier, the command and control inputs relevant to the units of each controller were listed according to game time and type of command and control input. The summaries of the decisions, which can be found in Appendix D, also referenced game time. Using game time as a reference, the researchers compared the substance of a decision communicated to a controller to the types of command and control inputs made for units under his authority. As a result of the comparison, each decision was placed into one of the following four categories:

1. Command and Control Input -- The decision was such that one or more command and control input could have been used to implement it; and in the minutes of or immediately following the decision, one or more implementing input could be identified from the records of inputs.

2. No Command and Control Input -- The decision was such that one or more command and control input could have been used to implement it, given the tactical situation. Based on a search of the computer records, however, implementing inputs could not be identified in the minutes of or immediately following the decision.

3. Questionable -- Decisions that met one or more of three criteria were placed in this category. First, because of the nature of the decision or its contingency on the specific tactical situation, there was doubt as to whether it could have been implemented through command and control inputs. Based on this first criterion, all warning orders were placed in this category unless the order could clearly not be implemented through one or more command and control inputs. Second, the decision was such that it could have been implemented through command and control inputs; however, the records were not clear as to whether one or more input had been made in response to it. Third, the decision was such that command and control inputs would have been initiated at a console other than the one observed.

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12. One of the researchers had participated in the content analysis of decisions. The other had served as the third reviewer of the summarized decisions.

4. Not Possible -- The decision was such that command and control inputs could not have been used to implement it regardless of the tactical situation.

RESULTS

Results for players' decisions are presented by the three research issues. Where appropriate, responses to the controller questionnaire are reviewed along with findings from the direct observations and content analyses.

Communicated Decisions

The fifth issue concerned the decisions that players communicated to controllers during training exercises. Compared to direct observations, the content analysis provides more reliable documentation of players' decisions. Thus, this issue will be discussed in terms of the latter.

For all four exercises, a total of 56 decisions was identified. In the two defense exercises, 26 decisions were identified; 30 decisions were extracted from the attack exercises. Summaries of the 56 decisions are presented in Appendix D. An attempt was made to summarize each decision so that it would be intelligible to a reader not having monitored the exercise. The 56 decisions were categorized according to the major activities, actions, or objectives directed in them. The categories and number of decisions in each category are listed in Table 9. Inspection of this table reveals that decisions communicated to the observed forward company controllers most frequently concerned maneuver.

Tape-recorded communications were compared with the observation forms to determine if a decision identified on a tape recording had also been identified when the communications were directly monitored. The relevant data (frequencies and proportions) are shown in Table 10 for each separate exercise and for all four exercises combined. Of the 56 decisions identified from the tape recordings, 42, or 75 percent, had also been identified when communications were directly monitored.[13]

The summaries of the decisions in Appendix D do not fully describe the context in which the decisions were made. In some instances, a rich interchange between players and a controller occurred prior to the communication of a decision. A partial documentation of this interchange was undertaken as part of the content analysis. For each decision,

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13. A total of 66 decisions was identified in directly monitoring communications. Of the 66, 42 or .66 were also identified from the tape-recorded communications.

Table 9

Categories of Decisions:

Content Analysis

Decision Category	Frequency
Move/maneuver unit	23
Warning order (e.g. prepare to be relieved)	6
By-pass opposition	5
Fire support/allocation of fires	5
Halt movement/do not proceed	3
Defend/hold position	3
Attack	3
Task organization	3
Continue mission/firing	2
Switch radio frequency	1
Assume reserve mission	1
Investigate problem	1

Table 10

Frequency & Proportion of Decisions:

Content Analysis & Observation[a]

Exercise	Identification During Observation		Total
	Yes	No	
Defense - 1	11 / 1.00	0 / .00	11
Attack - 1	9 / .56	7 / .44	16
Defense - 2	12 / .80	3 / .20	15
Attack - 2	10 / .71	4 / .29	14
Total	42 / .75	14 / .25	56

[a]Numbers in a cell represent the frequency (top number) and proportion (bottom number) of decisions identified in content analysis and either identified or not identified during direct observation of the exercise.

judgments were made about the conditions that "prompted" it. That is, each decision was to be classified as either (a) a direct response to conditions or problems communicated to the TOC by the controller or (b) a general response to non-specific long-term developments.[14]

Table 11 displays the frequency and proportions of "direct" and "general" decisions for each exercise and for all exercises together. This table shows:

1. Across exercises, there was a tendency for most decisions to be made in direct response to conditions or problems communicated to the TOC by controllers.

2. The trend just described was somewhat more pronounced in the attack than in the defense.

3. There appeared to be an effect for player group. That is, the proportion of direct decisions was greater in the exercises for the National Guard command group (Defense-2 and Attack-2) than in the exercises for the active duty group. (Defense-1 and Attack-1).

The data in Table 12 pertain to direct decisions. In the table are presented: (1) the game time of a decision, (2) the number of communications conveying information about the conditions or problem which the decision was in response to, (3) the game time of the first such communication, and (4) the difference between the game time of the decision and the first communication. As presented in the table, the median number of communications that preceded a communication and that transmitted instigating information was two. A median interval of 1.75 minutes elapsed between the first communication and the decision. There appears to have been a tendency for the National Guard command group to communicate decisions less quickly than the active duty group.

A review of the summarized decisions (Appendix D) suggested that several decisions differed not only in terms of their responsiveness to directly communicated or general events. In addition, controllers appeared to have "requested" decisions in several instances, that is, to have expressed the desire for further guidance, instructions, or actions from the players. An ad hoc inspection of the decisions led to the estimates that for Defense-1, Defense-2, Attack-1, and Attack-2, the proportions of requested decisions were as follows, respectively: .09, .60, .38, and .71.

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14. The decision was categorized as unknown if it could not be placed in either of the other categories.

Table 11

Conditions Prompting Decisions:

Content Analysis[a]

Exercise	Prompting Conditions			Total
	Direct	General	Unknown	
Defense - 1	4 .36	7 .64	0 .00	11
Attack - 1	7 .44	7 .44	2 .12	16
Defense - 2	9 .60	4 .27	2 .13	15
Attack - 2	14 1.00	0 .00	0 .00	14
Total	34 .61	18 .32	4 .07	56

[a]Numbers in a cell represent the frequency (top number) and proportion (bottom number) of decisions judged to have been prompted by direct, general, or unknown conditions.

Table 12

Frequency & Time of Communications

Preceding Direct Decisions: Content Analyses

Exercise	(1) Decision Time[a]	(2) No. of Preceding Commos	(3) Time of First Commo[a]	(4) Diff. Between (1)&(3)[b]
Defense - 1	0348	2	0346	2
	0403	2	0402	1
	0437	2	0436	1
	0438	1	0438	0
		Md=1.8		Md=1.0
Attack - 1	0620	2	0619	1
	0630	1	0630	0
	0632	1	0632	0
	0637	3	0617	20
	0641	2	0637	4
	0717	3	0706	11
	0725	1	0725	0
		Md=1.75		Md=1.0
Defense - 2[b]	0347	4	0344	3
	0350	1	0350	0
	0405	2	0400	5
	0414	2	0411	3
	0421	2	0418	3
	0445	3	0441	4
	0452	2	0451	1
	0518	3	0514	4
		Md=2.25		Md=3.2

Continued

Table 12

		(Commos)		(Min)
Attack - 2	0553	5	0547	6
	0602	1	0602	0
	0603	1	0603	0
	0609	1	0609	0
	0619	2	0617	2
	0619	1	0619	0
	0626	1	0626	0
	0632	2	0631	1
	0647	3	0645	2
	0647	3	0645	2
	0719	2	0717	2
	0735	2	0730	5
	0800	2	0758	2
	0813	3	0810	3
		Md=1.9		Md=1.7
Total		Md=2.0		Md=1.75

[a] In game minutes.

[b] One decision was left out because of difficulty in following the tape recorded communication.

These data suggest effects for both groups and exercises. That is, .26 of the decisions communicated by the active duty command group (Defense-1 and Attack-1) appeared to be requested decisions while the National Guard command group communicated .66 requested decisions (Defense-2 and Attack-2). For both groups combined there were .38 and .53 requested decisions in the defense and attack exercises, respectively.

In summary, players did communicate decisions to the forward company controllers during both types of exercises. A large proportion of the decisions appear to have concerned maneuver. The conditions associated with the communication of decisions appeared to vary with the type of training exercise and with player group. Compared to the active duty command group, the National Guard command group appeared to communicate more decisions in direct response to problems/conditions brought to their attention by the controllers. A greater proportion of the decisions of the National Guard command group also appeared to be requested. Similar differences tended to characterize the attack and defense. Compared to the defense exercises, more decisions in the attack exercises appeared to be "direct" and "requested."

Implementation of Decisions

The sixth issue -- whether players' decisions were implemented through the math model -- concerned the relationship between (a) the players' decisions communicated to controllers and (b) the controllers' responses to these decisions. The initiation of command and control inputs will be presented first.

Command and Control Inputs

As reported earlier, 56 decisions were found in the tape-recorded communications between players and controllers. The implementation of these decisions through command and control inputs was of particular interest. To investigate this relationship, it was necessary to identify the command and control inputs that had been made during the exercises and to relate these to the players' decisions. Data on command and control inputs were available from two sources: computer records and the records of command and control inputs made by observers during the exercises.

According to direct observations of the four exercises, a total of 320 command and control inputs was initiated for units under the authority of the observed controllers. Table 13 is based on computer records. It displays the frequency of maneuver, ground fire, and all other types of command and control inputs made during each exercise. Inspection of this table reveals the following:

Table 13

Frequency of Command and

Control Inputs: Computer Records

C&C Input Option	Defense 1	Attack 1	Defense 2	Attack 2	Total Defense	Total Attack	TOTAL
Maneuver	59	102	33	92	92	194	286
Ground Fire	23	30	49	91	72	121	193
Other[a]	8	10	0	11	8	21	29
Total	90	142	82	194	172	336	508

[a]These consisted of "resupply", "control measure", or "task organization."

1. For all exercises combined, "maneuver control" and "ground fire control" were made more frequently than all other types of inputs; maneuver control was the most frequent type of command and control input.

2. There appears to have been a group effect in that fire control inputs were made more frequently during the exercises for the National Guard command group (Defense-2 and Attack-1) than in the exercises for the active duty group (Defense-1 and Attack-1).

3. The total number of inputs recorded by the computer was 508, which greatly exceeds the 320 inputs identified by the observers.

Responses to item 29 of the controller questionnaire permitted computation of controllers' perceptions of the extent to which the various command and control inputs were made. The median proportions reported by controllers at the forward company console were .50, .35, and .25, respectively, for "maneuver control", "fire control", and all "other" inputs together. These estimates are generally compatible with results shown in Table 13.

Responses to decisions. The 56 decisions were sorted in terms of whether they had been identified in direct observation of an exercise. If a decision had been identified, the relevant observation form was examined to determine if one or more of the available command and control input options had been used. The data are presented in Table 14 in terms of the frequencies and proportions for each and all exercises combined.

The data in Table 14 are suspect due to the discrepancy (reported earlier) between the number of command and control inputs identified in directly observing exercises and the number identified from computer records. Consequently, computer records of command and control inputs were analyzed to determine further if the 56 decisions had been implemented by command and control inputs. As mentioned earlier, each decision was placed into one or more of the following four categories through this analysis: (a) command and control input (C&C Input) identified for the decision; (b) no command and control input (No C&C Input) identified for the decision; (c) identification of command and control input questionable (Questionable); and (d) command and control input not possible (Not Possible). Table 15 displays the frequency and proportion of decisions placed in each category as a result of this analysis.

Tables 16, 17, and 18 show the relationship between results based on direct observation data (Table 14) and the results based on the computer records (Table 15). That is, Table 16 displays for all four exercises the number of decisions in each combination of the following: (a) identification of decision during direct observation of an exercise; (b) observed occurrence of command and control input for decisions identified during an exercise (yes, no, or unknown), or estimation of the possibility

Table 14

Decisions Identified During

Observation & Content Analysis[a]

Exercise	Identification of Decision During Exercise								Total
	Identified				Unidentified (Possible C&C Inputs)				
	C&C Input	No C&C Input	Unknown	Sub-Total	C&C Input	No C&C Input	Unknown	Sub-Total	
Defense - 1	10 / .91	1 / .09	0 / .00	11	0 / .00	0 / .00	0 / .00	0	11
Attack - 1	3 / .33	3 / .33	3 / .33	9	7 / 1.00	0 / .00	0 / .00	7	16
Defense - 2	6 / .50	6 / .50	0 / .00	12	2 / .67	0 / .00	1 / .33	3	15
Attack - 2	5 / .50	5 / .50	0 / .00	10	3 / .75	1 / .25	0 / .00	4	14
Total	24 / .57	15 / .36	3 / .07	42	12 / .86	1 / .07	1 / .07	14	56

[a]Numbers in a cell represent the frequency (top number) and proportion (bottom number) of decisions which were identified (or not) during direct observation of exercises and for which, based on observation records, command and control inputs were made.

Table 15

Frequency & Proportion of Decisions Enacted by

C&C Inputs: Computer Records[a]

Exercise	Implementation of the C&C Input				TOTAL
	C&C Input	No C&C Input	Question-able	Not Possible	
Defense-1	8 / .73	1 / .09	2 / .18	0 / .00	11
Attack-1	4 / .25	6 / .37	6 / .37	0 / .00	16
Defense-2	7 / .47	3 / .20	4 / .27	1 / .07	15
Attack-2	4 / .29	4 / .29	5 / .36	1 / .07	14
TOTAL	23 / .41	14 / .25	17 / .30	2 / .04	56

[a]Cell entries represent the frequency (number in top portion) and proportion (bottom portion) of decisions placed in each category in the content analysis of computer records.

Table 16

Frequency of Decisions Enacted by C&C Inputs:

Observations & Computer Records[a]

Computer Record	Decisions Identified During Exercise				Decisions Not Identified During Exercise				TOTAL
	Observed C&C Input				Estimated C&C Input Potential				
	Yes	No	N/A	Total	Yes	No	N/A	Total	
C&C Input	17	3	0	20	3	0	0	3	23
No C&C Input	3	7	1	11	3	0	0	3	14
Question-able	4	4	2	10	6	0	1	7	17
Not Possible	0	1	0	1	0	1	0	1	2
TOTAL	24	15	3	42	12	1	1	14	56

[a]Entries represent the relationship between the classification of decisions in the analysis of computer records of command/control inputs and the results based on the content analysis and direct observations.

Table 17

Frequency of Decisions Enacted by C&C Inputs

in Defense Exercises: Observations & Computer Records[a]

Computer Record	Decisions Identified During Exercise				Decisions Not Identified During Exercise				TOTAL
	Observed C&C Input				Estimated C&C Input Potential				
	Yes	No	N/A	Total	Yes	No	N/A	Total	
C&C Input	13	0	0	13	2	0	0	2	15
No C&C Input	1	3	0	4	0	0	0	0	4
Question-able	2	3	0	5	0	0	1	1	6
Not Possible	0	1	0	1	0	0	0	0	1
TOTAL	16	7	0	23	2	0	1	3	26

[a]Entries represent the relationship between the classification of decisions in the analysis of computer records of command/control inputs and the results based on the content analysis and direct observations.

Table 18

Frequency of Decisions Enacted by C&C Inputs

in Attack Exercises: Observations & Computer Records[a]

Computer Record	Decisions Identified During Exercise				Decisions Not Identified During Exercise				TOTAL
	Observed C&C Input				Estimated C&C Input Potential				
	Yes	No	N/A	Total	Yes	No	N/A	Total	
C&C Input	4	3	0	7	1	0	0	1	8
No C&C Input	2	4	1	7	3	0	0	3	10
Question-able	2	1	2	5	6	0	0	6	11
Not Possible	0	0	0	0	0	1	0	1	1
TOTAL	8	8	3	19	10	1	0	11	30

[a]Entries represent the relationship between the classification of decisions in the analysis of computer records of command/control inputs and the results based on the content analysis and direct observations.

of implementing the decision by command and control inputs for decisions not identified during an exercise (yes, no, or unknown); and (c) judgments about command and control inputs from the computer records (C&C Input, No C&C Input, Questionable, or Not Possible). Tables 17 and 18 display similar data for the two defense exercises and the two attack exercises, respectively.

Data for the 42 decisions that had been directly observed during the exercises can be used to index agreement between the results based on direct observation and computer records. As presented in Tables 16-18, three patterns of agreement emerge. First, certain results of both analyses are in agreement. The following decisions follow this pattern: (a) decisions judged to have been implemented by command and control inputs in both analyses, (b) decisions judged not to have been implemented by command and control inputs in both analyses, and (c) decisions judged not to have been implemented by command and control inputs based on observational data and classified as Not Possible in the analysis of computer records. The second pattern is disagreement in which decisions judged to have been implemented by command and control inputs in one analysis were judged not to have been so implemented in the other analysis. All decisions that were classified as doubtful (that is, Questionable or N/A) represent a third pattern.[15] Inspection of Table 16 indicates that the results for 25 (or .60) of the 42 decisions were in agreement. There was clear disagreement for 6 (or .14) of the decisions. The agreement for 11 (.26) was doubtful. These proportions suggest that even though observation data on the implementation of decisions through command and control inputs are not totally reliable, these data were probably more reliable than the original discrepancy indicated.

The data in Tables 16-18 appear to provide the most reliable descriptions of the frequency of decisions implemented through command and control inputs. Of the the 42 decisions identified in directly observing the exercise (Table 16), 20 were judged to have been implemented by one or more command and control inputs in the analysis of computer records. An additional four decisions were classified as Doubtful; however, these decisions were observed to have been implemented through command and control inputs during the exercises. Thus, the data in Table 16 indicate that 20-24 (or .57 at the most) of the 42 decisions that had been directly observed resulted in command and control inputs. Inspection of Tables 17 and 18 suggests that according to these criteria relatively more decisions in the defense exercises (.65 at the most) resulted in command and control inputs than in the attack exercises (.47 at the most).

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15. This third pattern was established for two reasons. First, the classification systems in the two analyses did not directly correspond. Second, judgments of Questionable and N/A indicated that the analysts/observers were uncertain.

As part of the direct observation procedures, records were kept of a controller's response to a decision. For each decision, the records identified the combination of the following that described the response: none (no observable response), communication with another controller, or command and control inputs. The frequency and proportion of decisions enacted by each logical combination of controller responses are displayed in Table 19. Of the 66 decisions identified[16], 32 were implemented through command and control inputs alone or through command and control inputs in conjunction with communications to another controller. This proportion (.48) approximates that reported earlier for the attack exercises (.47 for decisions observed during the exercises); however, it is lower than that found for all exercises combined.

Initiation of inputs. As described earlier, the analysis of computer records produced a category of decisions that appeared to have been implemented through command and control inputs. A decision was placed in this category only if one or more command and control input could be located that met these criteria: (a) the type of command and control input (for example, maneuver) was suited to implement the decision and (b) the input occurred within the minutes of or immediately succeeding the communication of the decision. Each input judged by the two reviewers to meet these criteria was tagged. The inputs identified in this manner are considered to represent the inputs that were directly initiated by players' decision.

Table 20 presents the frequency and proportion of inputs initiated by players' decisions. The proportions were calculated using the figures in Table 13. The following describes the results in Table 20:

1. Of all command and control inputs made during the four exercises, .21 appeared to be made in direct response to players' decisions.

2. Of all types of inputs, maneuver control was made most frequently (and practically exclusively) in response to players' decisions.

3. Compared to the attack exercises, a relatively greater proportion of the inputs in the defense exercises appears to have been made in response to players' decisions.

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16. This number of decisions is greater than the number tallied in the content analysis. The discrepancy is partly due to, first, the multiple military roles assumed by controllers and second, an observer's tendency to record data for roles other than those being directly studied.

Table 19

Controllers' Responses to Decisions:

Observation Data[a]

Exercise	Controller Position	Controller Response: None	Commo with Controller	CC&C Input	Commo & C&C Input	Total
Defense-1	Left	4 / .67	1 / .16	1 / .16	0 / .00	6
	Right	3 / .27	0 / .00	4 / .36	4 / .36	11
Attack-1	Left	5 / .33	2 / .13	7 / .47	1 / .07	15
	Right[b]	1 / .50	0 / .00	1 / .50	0 / .00	2
Defense-2	Left	6 / .75	0 / .00	1 / .12	1 / .12	8
	Right	3 / .33	1 / .11	4 / .44	1 / .11	9
Attack-2	Left	1 / .20	1 / .20	2 / .40	1 / .20	5
	Right	5 / .50	1 / .10	2 / .20	2 / .20	10
Total Defense	Left	10 / .71	1 / .07	2 / .14	1 / .07	14
	Right	6 / .30	1 / .05	8 / .40	5 / .25	20
	Left & Right	16 / .47	2 / .06	10 / .29	6 / .18	34
Total Attack	Left	6 / .30	3 / .15	9 / .45	2 / .10	20
	Right	6 / .50	1 / .08	3 / .25	2 / .17	12
	Left & Right	12 / .38	4 / .12	12 / .38	4 / .12	32
Total Left Position		16 / .47	4 / .12	11 / .32	3 / .09	34
Total Right Position		12 / .38	2 / .06	11 / .34	7 / .22	32

[a]Entries represent the frequency (top number in a cell) and proportion (bottom number in a cell) of decisions to which a controller occupying a designated console position (left or right) made one of the denoted responses during an exercise.

[b]The controller located in the right position operated the command & control input devices.

Table 20

Frequency and Proportion[a] of Command & Control Inputs in Response to Players' Decisions: Computer Records

C&C Input Option	Defense 1	Attack 1	Defense 2	Attack 2	Total Defense	Total Attack	TOTAL
Maneuver	35 / .59	16 / .16	29 / .88	11 / .12	64 / .70	27 / .14	91 / .32
Ground Fire	0 / .00	0 / .00	14 / .29	0 / .00	14 / .19	0 / .00	14 / .07
Other[b]	0 / .00	0 / .00	0 / .00	0 / .00	0 / .00	0 / .00	0 / .00
Total	35 / .39	16 / .11	43 / .52	11 / .06	78 / .45	27 / .08	105 / .21

[a]Proportions (bottom number in a cell) were calculated by dividing the number of inputs judged to be in response to players' decisions (top number in a cell) by the total number of inputs in the exercise (from corresponding cells in Table 14).

[b]These consisted of "resupply", "control measure", or "task organization."

In response to questionnaire item 30, six controllers of the forward and fire control consoles estimated the proportion of their command and control inputs that had been based on the decisions/commands/orders of players. Estimates of the proportions ranged from .10-.80, with a median estimate of .40. Thus, the proportion estimated by controllers was appreciably greater than the proportion (.21) based on the analysis of computer records of inputs. It should be noted that controllers' responses to items 31 and 39 suggest types of players' decisions that they were unable to implement through command and control inputs.

Related findings. Several questionnaire items (35, 40, 44, 45, 46, 47, 49, and 51) concerned potential problem areas associated with making command and control inputs. Responses to these items may be summarized as follows:

1. Ten of eleven respondents believed that they were able to plan and implement command and control inputs so that they could affect the math model in a timely fashion (item 35).

2. Most respondents (seven of eight) believed that the model provided readily accessible information indicating that command and control inputs had been received and taken into account by it (item 40).

3. No controller appears to have experienced any difficulty in selecting command and control inputs (or options within input types) that would implement a player's decision (items 46-47).

4. Most respondents (eight of ten) believed that there were no problems associated with command and control inputs unique to the different training exercises (item 44).

5. Additions to the elements modeled by the computer and improvement of weapon effects curves were cited as changes that would improve the responsiveness of the math model to the decisions of players and controllers (item 45).

6. Respondents at all consoles found problematic the need to adjust the scale or portion of the map viewed when making a command and control input (item 49).

7. Of three controllers from the fire support console, two indicated that a backlog of inputs had caused untimely delays in entering their inputs to the math model (item 49).

8. Of ten respondents, eight indicated that the requirement for the center controller to make command and control inputs for all three

controllers at a console reduced the timeliness of inputs to the model. According to six respondents,[17] this arrangement tended to overload the operator of the command and control input mechanisms during peak periods.

Based on these responses, it appears that the means for entering command and control inputs to the math model were affected by three types of problems. The first involved those areas in which the math model was incomplete or inaccurate. A second type was mechanical -- adjusting the scale or area displayed on the graphics CRT. The third consisted of the delays caused by channeling the command and control inputs of all three controllers at a console through a single controller.

Summary. Based on results for a sample of the players' decisions, it appears that somewhat more than .50 of the decisions communicated to forward company controllers were implemented by interaction with the math model, that is, through command and control inputs. Computer records and controllers' reports suggest that the two most frequent types of command and control inputs made from the forward company console were maneuver control and fire control. It appears that of all inputs made by the observed controllers, approximately .20-.40 were in direct response to players' decisions. Responses to the controller questionnaire suggested that the responsiveness of the math model would be improved by increases in the accuracy and completeness of the model. Controllers' responses also identified three factors that contribute to delays in entering command and control inputs to the math model.

Feedback

The last research issue concerned feedback, that is, whether players received feedback about the implementation of their decisions. This issue was investigated by first describing the feedback that players received to their decisions. The relationship among decisions, the implementation of decisions through command and control inputs, and feedback was then explored.

As part of the content analysis, a controller's feedback to each decision that had been communicated to him was identified and summarized. The summaries are presented in Appendix D along with the summaries of the decisions. The analysts also determined whether the feedback had been requested by the TOC or had been provided automatically. The results are presented in Tables 21 and 22.

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17. The two respondents who had most consistently served as operators of the command and control input mechanism were not among the six.

Table 21

Frequency & Proportion of Decisions
Receiving Feedback: Content Analysis[a]

Exercise	Feedback				Total
	Yes			No	
	Automatic (A)	Requested (R)	A&R		
Defense - 1	1 / .09	1 / .09	0 / .00	9 / .82	11
Attack - 1	4 / .25	3 / .19	0 / .00	9 / .56	16
Defense - 2	10 / .67	1 / .07	0 / .00	4 / .27	15
Attack - 2	4 / .29	1 / .07	2 / .14	7 / .50	14
Total Defense	11 / .42	2 / .08	0 / 0	13 / .50	26
Total Attack	8 / .27	4 / .13	2 / .07	16 / .53	30
Total	19 / .34	6 / .11	2 / .04	29 / .52	56

[a]Top number in a cell represents the frequency, bottom number the proportion of decisions entries.

Table 22

Median Interval Between Communication

of Decision & Receipt of Feedback: Content Analysis

	Median Interval, in Minutes	Frequency of Decisions Receiving Feedback
Defense - 1	5.5	2
Attack - 1	6.0	7
Defense - 2	2.75	11
Attack - 2	6.0	7
Total	5.6	27

Table 21 displays the frequency and proportion of decisions to which a controller was observed to provide feedback, categorized as requested, automatic, or both. Based on Table 21, it appears as if players received feedback to approximately .50 of their decisions. Depending on the exercise, players received feedback to .07 to .19 of their decisions only after they had requested it. In response to item 42 of the questionnaire, controllers also estimated the proportion of players' decisions to which they had provided feedback. The forward company controllers estimated that they had communicated feedback to .65 (median) of the players' decisions.

Table 22 describes the timing of feedback. That is, it presents the median interval (in minutes) between the game time of a decision and the game time of the first communication providing feedback. It appears as if the median delay between a decision and the receipt of feedback was somewhat more than five minutes.

In order to further describe CATTS as an interactive system, the relationship among players' decisions, their implementation through command and control inputs, and the receipt of feedback was explored. To accomplish this, the 42 decisions that had been extracted from the tape-recorded communications and that had been identified in directly observing the exercises were used. Results reported earlier were used to determine if a decision had been implemented through command and control inputs. Accordingly, a decision was considered to have been implemented through command and control inputs under one of two conditions: (a) the decision was classified as having been implemented through command and control inputs in the analysis of computer records or (b) the decision was classified as "Doubtful" in the analysis of computer records, but implementing command and control inputs had been identified in directly observing the exercises. Similarly, a decision was considered not to have been identified through command and control inputs under two conditions: (a) the decision was classified as not having been implemented through command and control inputs (that is, "No C&C Input" as defined earlier) in the analysis of computer records or (b) the decision was classified as "Doubtful" in the analysis of computer records and no implementing decision had been identified for it in directly observing the exercises. Finally, the implementation of a decision through command and control inputs was considered to be "doubtful" if the decision had been so classified in the analysis of computer records and if the implementation of the decision was unknown ("N/A") based on the direct observations. The results for feedback just reviewed were used to determine if feedback had been provided to the decisions.

The results are presented in Table 23. Inspection of this table reveals that .26 of the 42 decisions resulted in both command and control inputs and feedback. Otherwise, controllers appear to have either provided no feedback (.57) or provided feedback without having made prior command and control inputs (.17).

Table 23

Frequency & Proportion of Decisions Followed

by Command & Control Inputs & Feedback[a]

C & C Input	Feedback	Exercise		Total
		Defense	Attack	
Yes	Yes	7 / .30	4 / .21	11 / .26
	No	8 / .35	5 / .26	13 / .31
No	Yes	3 / .13	4 / .21	7 / .17
	No	5 / .22	4 / .21	9 / .21
Question-able	Yes	0 / .00	0 / .00	0 / .00
	No	0 / .00	2 / .11	2 / .05
TOTAL		23 / 1.00	19 / 1.00	42

[a]This table is based on the 42 decisions identified in both direct observation and content analysis of decisions.

Neither the direct observations nor the content analyses yielded systematic data regarding the relationship of feedback to outputs of the math model. As mentioned earlier, however, the general impression of the two researchers conducting the content analysis of decisions was that the information provided as feedback could have been based on outputs of the math model. This impression is not inconsistent with responses received to item 43 on the controller questionnaire. In response to this item, a controller was to estimate the proportion of times that his feedback to players was based on each of the following: (a) computer outputs alone, (b) a combination of computer-generated and fabricated information, and (c) fabricated information alone. The median proportions estimated by forward company controllers were .40, .56, and .10, respectively, for the three sources just presented. Thus, the forward company controllers estimated that feedback was completely based on computer-generated information in .40 of the instances in which they communicated feedback. Respondents were also asked to cite reasons for communicating feedback that was not based on computer outputs. The reasons cited appear to fall into three categories. First, there were areas of incompleteness and inaccuracy in the math model. Responses to questionnaire items 32 and 33 are relevant to this reason. These items were intended to elicit responses concerning the predictability and credibility of the effects of command and control inputs. Inputs related to fire control, maneuver control, and the air module were among the inputs mentioned by respondents. Second, system failures necessitated fabrication. Third, controllers were motivated to promote realism.

In summary, results of the content analysis of decisions suggest that players received feedback to approximately .50 of the decisions that they had communicated to players. This estimate is somewhat lower than the median estimate (.65) advanced by controllers at the forward company console. Further analysis revealed that .26 of the players' decisions resulted in both command and control inputs and feedback. Forward company controllers estimated that feedback was based completely on computer-generated information in .40 of the instances in which they communicated feedback. Controllers' responses suggest three categories of reasons for not having completely based feedback on computer-generated information: validity of the math model, system failures, and realism.

DISCUSSION

This research was to describe the flow of information among controllers, players, and the math model in CATTS training exercises during the period of system definition research. The research was planned to collect descriptive data regarding seven research issues concerning controller-to-player communications and players' decisions. It was anticipated that the results would also have implications for future research and development of CATTS. Certain limitations of the study caution against broad generalization from the results presented in this document. These will be outlined prior to discussion of the results and their implications.

LIMITATIONS

The basic limitations of the study appear to stem from three sources: (a) the context in which it was conducted, (b) the individuals/group on which data were collected, and (c) the design and execution of the study as a whole.

Data were collected within the context of the training established for the overall period of CATTS system definition research. For the most part, the training exercises studied were conducted as free-play exercises. The results of this study, consequently, are only applicable to that type of exercise. As applied in CATTS, the concept of free-play was basically synonymous with unplanned. That is, the training experiences of a particular group were managed by the outcomes of the math model and controllers' interpretations of what would constitute realistic performance in that context. One implication of such an approach is that even though different training groups may have had equally realistic training experiences in a particular type of exercise, the events comprising different exercises could have varied dramatically. The results of the present study, therefore, stemmed from a deliberately uncontrolled and, therefore, unrepeatable context.

Three factors limit sample generalizability. First, the number of training groups was small. All data on controller-to-player communications were based on one training group. Two training groups participated in the research on player's decision making. Second, the sample of controllers was also small. As a result, a particular controller position (that is, the left, center, or right position at the forward company console) was manned by the same individual for practically all six training exercises. Thus, differences for controller positions reflect the individuals who held these positions as well as the effects of features (for example, accessibility to a particular output source) of the positions. Third, the sample was not representative of the potential users of CATTS. Controllers had actively participated in development of the demonstration system. Consequently, they were more familiar with the requirements to operate it

than the total population of potential users (presumably, military officers capable of conducting battalion-level training).

Finally, the design and execution of the study were such that it should be viewed as preliminary to more definitive research. Except for the controller questionnaire and general impressions, systematic study was limited to two of the controllers at the forward company console. Accordingly, interpretation of the results should be limited to the forward company console. Results of the questionnaire tend to be applicable to all controller consoles. As the sample of the respondents to the questionnaire was small (N = 12) and as the controllers had served different functions during training, the questionnaire was designed and administered to elicit response that reflected the unique and diverse experiences of the individual respondents. Due to this approach, the problem areas identified through the questionnaire often reflect the views of only one or two respondents. In addition, the time available for planning and conducting the study limited the extent to which instruments and procedures could be pretested or tested for reliability. Pre-testing could have offset one problem described earlier -- the apparent inability to reliably identify and record command and control inputs by directly observing the controllers' performances. One other design feature should be mentioned. Much of the data represent judgments of behavioral records. While constrained by the records, such data are nevertheless somewhat subjective.

RESEARCH ISSUES

The basic purpose of this study was to describe information flow in CATTS in terms of two interrelated phenomena: (1) controller-to-player communications and their relationship to computer outputs and (2) interaction of the math model with players' decisions. The study was designed in terms of seven research issues related to controller-to-player communications and players' decisions. While the results of this study are not definitive, they tend to support general conclusions regarding these issues.

Player-to-Controller Communications

Communications and related output sources. The first research issue on controller-to-player communications concerned the extent to which controllers' communications were based on computer outputs. In general, it appears as if controllers' communications tended to be based on computer outputs. As discussed more thoroughly later, however, all information received by players was not necessarily identical to computer-generated information. Rather, it appears that controllers combined computer outputs with information fabricated by them during training exercise. These findings appear to point out the criticality of the math model. They also underscore that controllers serve as the link between computer-generated information and its dissemination to the player group. Based on the

latter, controller training and aids should be designed to insure that controllers communicate computer-generated information to players in a manner congruent with the training concept for CATTS.

Utilization of outputs. The second issue concerned the utilization of the computer-output sources at a controllers' disposal. Research on this issue focused on the extent to which the various sources both served as a basis of controller-to-player communications and were used to meet the controllers' own information needs. Through the controller questionnaire, an attempt was also made to identify problems associated with the use of the computer-output sources.

Computer-generated graphics, alert messages, and special status reports appear to have been the principal sources of controllers' communications. Certain modifications would increase their utility. It appears, for example, that the multiple functions of the graphic CRT and its operation caused some delays in receipt of graphical information. Similar problems appear to have reduced the accessibility of information through special status reports. It is possible that these problems could be handled by increasing the number or arrangement of the present input devices. There were also reports that additional types of alert messages are needed by controllers at particular consoles. Finally, the 15-minute summary was apparently not used because of the trade-offs between its perceived value and the requirements to make use of it. One implication of this finding is that, depending on user requirements, the 15-minute summary is either unnecessary for training or should be revised so that its perceived utility is increased.

Player requested information. The third issue -- whether information requested (and received) by players was based on computer outputs -- was not directly investigated. As reported earlier for the first issue, .98 of the communications in which players provided information were judged to have been based on information from one or more computer-output sources. Moreover, most respondents to the controller questionnaire believed that no difference existed between the quality of information communicated at a player's request and the quality of information communicated at their own instigation. Thus, it appears likely that information requested by players, as well as information automatically provided, was based on computer outputs.

Transformation of outputs. Results from the content analysis of controller-to-player communications and the controller questionnaire addressed the issue of whether and how controllers altered computer-generated information prior to communicating it to players. Results indicated that all communications appeared to exhibit one or more of three types of transformations. The most frequently identified transformation involved the form of information, that is, changing the manner of expressing (or presenting) computer-generated information without altering

the denotative meaning of the information. The other two were: (a) modification of the specificity of information in computer outputs (alteration of detail) and (b) the addition of information related to that conveyed in computer outputs but not actually provided in the outputs. Controllers cited three types of reasons for having transformed computer outputs: promotion of realism, invalidity of the math model (that is, areas of inaccuracy or incompleteness), or system failures.

These results have implications for future work on CATTS. First, they underscore the importance of the math model and of its validity to training. The specificity, accuracy, and completeness of its outputs appear to have influenced the ways in which controllers mediated between the math model and the player group. More specifically, perceived inadequacies in outputs of the math model prompted controllers to manipulate the outputs prior to communicating them to players. In addition, these findings emphasize the criticality of the control system. Outputs of the math model were not simply relayed to players. Rather, this information was modified and then transmitted by controllers. Thus, the manner in which controllers transform computer outputs appears to be critical to the training effectiveness of CATTS. Based on this view, it appears that controllers should be trained and provided procedural aids to guide and insure the effectiveness of CATTS training. The nature of the training and procedural aids would of course be defined by the training plans for CATTS. Results bearing on the present issue suggest that the training and procedural aids should guide controllers in: (a) promoting realism, (b) compensating for computer outputs that are inadequate because of the inaccuracy and incompleteness of the math model, (c) reducing the specificity of computer-generated information, and (d) continuing training during periods of system failures.

Players' Decisions

Communicated decisions. In the content analysis of decisions, a total of 56 decisions were identified as having been communicated to the two forward company controllers. Although the 56 decisions represent only a sample of the decisions made by the players, their documentation demonstrates the occurrence of an early and necessary phase of interaction between players' decisions and the math model -- the communication of decisions to controllers. It should be noted that the 56 decisions were extracted from tape-recorded communications which could be repeatedly reviewed. These communications had also been directly observed (monitored) during the corresponding training exercises by research personnel, but only 75% of the decisions had been detected during observation. This discrepancy indicated the potential unreliability of direct observation procedures in settings like CATTS. The implications of this discrepancy are also relevant to the recipients of players' decisions in CATTS. Controllers, too, may not have reliably recognized decisions that players communicated to them.

The conditions associated with players' decisions appeared to differ for the two training groups studied and for the two types of training exercises. Compared to the decisions communicated by the active duty command group, a greater proportion of the decisions of the National Guard group appear to have been prompted by problems or conditions directly communicated by controllers. In an ad hoc analysis, a relatively greater number of the decisions of the National Guard group appears also to have been requested by the forward company controllers. The actual cause of these and other differences for the two groups is unknown. It is possible, however, that they were due to the differing entry levels of the two groups. Within the framework of this interpretation, these results imply that training plans in CATTS should take group differences into account.

The differences between the defense and attack exercises also involved direct and requested decisions. That is, the frequencies of directly prompted and requested decisions were comparatively greater in the attack exercises. As other differences were found between those two types of exercises, it is possible that training plans should vary for attack and defense exercises.

Implementation of decisions. The sixth issue concerned a critical link in the interaction between players' decisions and the math model -- the implementation of players' decisions by the entry of command and control inputs that reflect the decisions' action implications. The relative extent to which commands to the math model were based on players' decisions, as opposed to decisions made by controllers, was also of interest. Results on the latter tend to indicate the extent to which the tactical situation modeled by the computer was dependent on players' decisions.

Based on the results of the content analyses and the controller questionnaire, it appears that somewhat more than half of the players' decisions were implemented through command and control inputs. These findings suggest that a relatively large proportion of the players' decisions had no direct effect on the math model. Several factors should be taken into account in appraising this finding. It is likely, for example, that many decisions did not require immediate actions given the tactical situation. Inspection of the decisions (see Appendix D) also reveals that several decisions would probably have been handled by controllers at other consoles (especially the fire support console). In addition, the results reflect the manner in which a decision was judged to have been implemented through command and control inputs. For the most part, such a judgment was based on the entry of appropriate command and control inputs within a relatively short time period after communication of a decision. Thus, the results do not reflect later actions that controller would deem necessary to adhere to a command group's decision. Such later

judgments by a controller, however, could reflect the decisions of a controller as much as decisions by a player group. Other findings concern differences for type of training exercise. It appeared as if a relatively greater number of the decisions in the defense were implemented by command and control inputs.

Based on both computer records and the controller questionnaire, the two most frequent types of inputs made at forward company console were maneuver control and fire control. Differences for training groups were found, however. Compared to the number of fire control inputs, relatively more maneuver control inputs were made during exercises for the active duty player group; the reverse was found for the National Guard group. In terms of the initiation of command and control inputs, it appears that most inputs were not in direct response to players' decisions. That is, results indicate that most inputs were initiated by controllers and were not directly based on players decisions. Thus, the extent to which the tactical situation modeled by the computer actually reflected a player group's decisions is questionable.

Responses to the controller questionnaire revealed three general problem areas. First, controllers tended to express the view that changes in accuracy and completeness of the math model would increase its responsiveness to decisions. The second and third areas involved delays in initiating command and control inputs. The requirement for the inputs of all controllers at a console to be entered by a single controller was cited as one source of delay. Delays were also attributed to the need to adjust the scale and terrain viewed on the graphics CRT prior to making inputs. It is possible that these problems could be offset by (1) reducing the multiple functions of the graphics CRT and its operator and/or (2) redistributing workload by altering the number or configuration of the present input/output devices.

In conclusion, it appeared that somewhat more than half of the players' decisions were implemented through direct command and control inputs. Command and control inputs tended to be initiated by controllers more frequently than by players. Like the results for the fifth issue, differences between the two player groups and the two types of training exercises suggest that these factors should be taken into account in plans for training in CATTS. Problems associated with the entry of command and

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18. That is, such judgments could be as closely associated with a controllers' decisions about the subsequent impact of immediate commands on the tactical situation as with a command group's original decisions about action requirements.

control inputs also tend to imply that in future work on CATTS, consideration should be given to the validity of the math model and to the distribution of functions and workload among the various console positions and input/output devices.

Feedback. The final research issue concerned feedback. Based on results pertaining to this issue, it is questionable whether the interactive capabilities of CATTS were fully utilized during training exercises in system definition research.

According to the concept of CATTS underlying the present study, training exercises would take full advantage of the intended interactive capabilities of the system only if players' decisions were enacted by inputs to the computer and if players then received feedback concerning the effects of their decisions on the modeled tactical situation. The results pertaining to feedback were as follows:

1. Players received feedback to approximately half of the 56 decisions that they communicated to the two forward company controllers.

2. Of a sample of the 56 decisions, somewhat more than one-fourth resulted in both command and control inputs and feedback. Of the remaining decisions, controllers either provided no feedback or provided feedback without having made prior command and control inputs.

3. Based on controllers' responses to the questionnaire, .40 of the instances in which they provided feedback were completely based on computer-generated information. In most of the remaining instances, feedback was composed of a combination of computer-generated and fabricated information.

Results on the enactment of decisions through command and control inputs and the receipt of feedback were based on only a sample of the decisions communicated during four training exercises. The results, nevertheless, raise questions about the extent to which the interactive capabilities of CATTS were used during training. In particular, they seem to suggest that each successive link in the chain between players' decisions, command and control inputs, and feedback was progressively weaker. That is, it appeared that somewhat more than half the decisions were implemented through command and control inputs and that perhaps half of these[19] were followed up by feedback. The cause of this apparent degradation is unclear and thus remains one of the implications for research and development of CATTS.

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19. This estimate is based on Table 23.

Results on feedback have other implications. Again, the importance of the validity of the math model is underscored. The reasons cited by controllers for communicating feedback based on fabricated information included inadequacies in the math model. Results also support the view that controllers should be trained and provided procedural aids to insure the effectiveness of CATTS. It appears that in addition to the areas mentioned earlier, training and procedural aids should guide controllers in the following: (a) recognizing decisions that should be implemented through command and control inputs, (b) acquiring and transmitting feedback from computer-generated information, and (c) providing feedback for decisions not implemented through command and control inputs.

SUMMARY

This study represents preliminary research on the Combined Arms Tactical Training Simulator (CATTS) in training exercises. The purpose of the study was to describe information flow in terms of seven research issues related to controller-to-player communications and the interaction of players' decisions with the CATTS math model.

The results support two general conclusions regarding information flow:

1. CATTS training exercises, as conducted during system definition research, were structured in terms of computer-generated information as mediated by controllers.

2. CATTS appears to have the potential to be an interactive system. The extent to which this potential was realized during system definition research is questionable. That is, the math model appears to have generated the tactical problems with which the players dealt. Developments within the model, however, were as much (and possibly more) influenced by command and control inputs initiated by controllers as by players decisions. Moreover, players' decisions were not such that they consistently resulted in command and control inputs followed by feedback to the players.

In terms of the specific research issues, the following conclusions were drawn:

1. Controllers' communications during training exercises were based on information generated by the CATTS math model.

2. Computer-generated graphics, alert messages, and special status reports were the principal sources of controllers' communications to players. Certain modifications would increase their utility.

3. Information specifically requested by players, as well as information automatically provided without its having been requested, appears to have been based on computer outputs.

4. Computer-generated information was not simply relayed to players. Rather, the information tended to be modified prior to transmission. The most frequent modification appears to have involved form, usually from graphic to verbal. Computer-outputs were also frequently modified by reducing the detail of outputs and by adding supplementary information.

5. Players did make and communicate decisions to controllers during training exercises. The conditions prompting players' decisions appeared to differ for the player groups studied and for the defense and attack exercises.

6. Of the players' decisions communicated to the observed forward company controllers, somewhat more than half appeared to be implemented through command and control inputs.

7. Command and control inputs tended to be initiated by controllers more frequently than by players. At the forward company console, the more frequent inputs in response to players' decisions were "maneuver control" and "fire control", with "maneuver control" being the most frequent.

8. Compared to the attack exercises, a greater proportion of the command and control inputs made in the defense exercises appears to have been in response to players' decisions.

9. CATTS training exercises appear to have been such that players received feedback to approximately half of their decisions and that an appreciably smaller proportion of players' decisions resulted in both command and control inputs and feedback.

In the discussion of the results, certain implications were advanced for consideration in future research and development of CATTS. Several of the implications (1-7 below) tend to be directly relevant to preparation of a training device requirement for a second-generation system. Applicability of the remaining implications tends to be wider. The implications are as follows:

1. The accuracy and completeness of the CATTS math model are critical. As determined by other research, areas in which the model is inaccurate and/or incomplete need to be identified for correction.

2. The present number of input/output devices should be altered to insure equal distributions of accessibility and workload.

3. Consideration should be given to reducing the multiple functions which the A/N CRT and graphic CRT serve.

4. The flexibility and completeness of the present graphic display subsystem should be retained and, if possible, increased.

5. The alert messages routed to each console should be assessed to determine whether any should be deleted or whether other types of messages are needed.

6. Consideration should be given to increasing the accessibility of information through special status reports.

7. The 15-minute summaries were not used by controllers during training exercises. Depending on user requirements for this type of output, the 15-minute summary should either be deleted from future versions of CATTS or revised so that its perceived utility is increased.

8. As used during system definition research, the training effectiveness of CATTS is dependent on the control system.

9. Controllers should be trained and provided procedural aids to insure the effectiveness of CATTS training.

10. Further research is required to determine how best to use CATTS to train in attack and defense operations.

11. Further research is required to determine the method -- or methods -- for training in CATTS.

12. Due to the apparent differences associated with training groups, training plans should take group differences into account.

APPENDIX A

TRAINING EXERCISES

This appendix contains descriptions of the training exercises on which data were collected. General overviews of the initial conditions for the FEBA GOLD and ATTACK exercises are provided first since all data were collected on variations of them. Information about the specific exercises studied is then reviewed.

FEBA GOLD

According to the FEBA GOLD scenario, a brigade had the mission of defending terrain along the east bank of the Suez Canal in the Sinai Desert. The brigade concept of the operation was to employ two defending battalion task forces along the canal, one in a sector to the north and the other in a sector to the south. The defense by the northern task force, which was composed of armor and mechanized infantry units, was simulated in the FEBA GOLD exercise.

A player group either executed a prepared (canned) task force operation plan or developed and executed its own plan. In the canned plan, the concept of the operation was for the task force to defend the sector with two teams along the forward edge of the battle area, with one team in the north and the other in the south. A third team served as the task force reserve and occupied a blocking position. The three teams were organized as follows:

North team --- mechanized infantry company plus one tank platoon attached.

South team --- mechanized infantry company (minus one platoon) plus one tank platoon attached.

Reserve team --- armor company (minus two tank platoons) plus one mechanized infantry platoon attached.

The simulated task force was supported by artillery, attack helicopters, and close air support. Two 155mm artillery final protective fires (FPF) were allocated to the forward team in the north. One 4.2in mortar FPF was allocated to the south team. The north team had priority of fires.

The defense of FEBA GOLD lasted until either (1) the simulated task force accomplished its mission or (2) the operation was terminated by the controller (by fiat or by ammending the player group's mission).

ATTACK

In the scenario for the ATTACK exercise, a brigade located in the Sinai desert had an attack mission. The brigade concept of the operation was to attack with three battalion-sized task forces in the attacking echelon and one task force as reserve. The center forward task force was to make the main attack and seize a terrain objective approximately 30 kilometers from its present position. The center task force and the execution of its attack was simulated in the ATTACK exercise.

As in FEBA GOLD, a player group either executed a canned operation plan or developed and executed its own plan. According to the concept of the canned plan, three company-sized teams were in the attacking echelon, with the center team making the main attack. A fourth team served as the task force reserve. The four teams were organized as follows:

North team --- armor company (minus one platoon) plus one mechanized infantry platoon attached.

Center team --- mechanized infantry company (minus one platoon) plus two tank platoons attached.

South team --- mechanized infantry company (minus one platoon) plus one tank platoon attached.

Reserve team --- armor company (minus two platoons) plus one mechanized infantry platoon attached.

The simulated task force was supported in the attack by artillery, attack helicopters, and close air support. A 20-minute artillery preparation commencing at H-20 was fired. The center team had priority of fires. The attack was planned in two phases. The first phase lasted until the task forces reaches its intermediate objectives. The second phase embraced the continuation of the attack to the final objectives.

The ATTACK exercise lasted until either (1) the simulated task force accomplished its assigned mission or (2) the chief controller terminated the operation (by fiat or by ammending the task force's mission).

CONTROLLER-TO-PLAYER COMMUNICATIONS

Data on the first four research issues were collected on the defense (FEBA GOLD) and attack (ATTACK) exercises for the second training group participating in system definition research. As mentioned earlier, this was an ad hoc group composed of officers stationed at the U.S. Army Armor School. This group developed its own operation plans for the FEBA GOLD and ATTACK scenarios. The simulated executions of the defense and attack lasted for approximately 209 and 199 minutes, respectively.

PLAYERS' DECISIONS

Data on the last three issues were based on the FEBA GOLD and ATTACK exercises for the third and fourth training groups. The third group, which participated in Defense - 1 and Attack - 1 (as denoted earlier), was a battalion-level command group from the 197th Infantry Brigade. The fourth training group participated in Defense - 2 and Attack - 2. This group was an incumbent command group of a battalion of the National Guard.

The player group participating in Defense - 1 executed the canned operation plan, with minor modifications. Defense - 1 lasted for approximately 130 minutes. The group developed and executed its own operation plan for Attack - 1, which lasted for approximately 175 minutes.

The player group in Defense - 2 implemented the canned operation plan for FEBA GOLD. Defense - 2 lasted for approximately

158 minutes. Prior to Attack - 2, the group developed its own operation plan. Attack - 2 was executed over a period of approximately 205 minutes.

APPENDIX B

CONTROLLER-TO-PLAYER COMMUNICATIONS

Controller-to-Player Communications: Observation Procedures

GENERAL APPROACH

For two training exercises, the performances of each of two controllers serving as forward company (or team) commanders were independently observed by a researcher. The primary responsibility of the observer was to closely track the performances of the controller in order to collect two types of data. First, he was to observe the activities of the controller in order to chart the successive "activity patterns" of the controller. That is, it was anticipated that during a training exercise, a controller would engage in complex sequences of behaviors as he interacted with the computer, communicated with players, executed his training responsibilities, etc. Eight such behavior sequences relevant to information acquisition and communication were identified and have been referred to as "activity patterns." As one category of data, each observer was to follow a controller's performance in order to identify and record the performances of the controller in terms of the eight activity patterns. The second category of data was directly associated with communications between the controller in his role as forward team commander and the player battalion commander (CO) and operations officer (S3). For purposes of this research, a communication was defined as the verbal dialogue that took place between the initiation and termination of a radio or telephone call to one or more of the participants being observed. The observer was to identify

each communication of the controller in his role as forward team commander with the player CO and/or S3 and to collect designated data that would facilitate a later analysis of the content of the communication. It should be noted that the communications between the observed controllers and the player CO and S3 were tape recorded in order to conduct the content analysis.

OBSERVATION GUIDELINES

The guidelines for the observers consisted of definitions and examples of the eight activity patterns, definitions of the communications data to be collected, and a set of procedural rules.

Activity Patterns

Communications with Players/Controllers via Radio, Telephone, Intercom, or Face-to-Face --- This activity pattern includes any combination of the performances of the controller involved in (a) the initiation of radio/telephone/intercom/face-to-face messages, (b) the receipt of such messages, (c) as well as the verbal interactions of the controller in communicating with other controllers or with any player except the Bn CO or S3.

Performances representing this activity pattern include the following:

1. verbal interaction with a player/controller, other than the player CO and S3 (except for those communications specified in other activity patterns below)

2. pressing a communications button (radio, telephone, or intercom) on the communications panel to initiate or receive a communication, followed by verbal interaction with players/controllers other than the player CO and S3 (except for those communications specified in other activity patterns below).

3. tasks 50 and 53-57 in the Interim Controller Handbook .

Communications with the Player CO and S3 via Radio or Telephone --- This activity pattern is represented by (a) any combination of performances involved in the initiation or receipt of radio/telephone messages as well as (b) the verbal interactions of the controller when communicating with the player Bn CO and/or S3.

Performances representing this activity pattern include the following:

1. verbal interaction with the player CO and/or S3 over the radio or telephone.

2. pressing a communications button on the communications panel to initiate or receive a communication, which may be followed by the type of communication just described.

3. tasks 50 and 53-57 in the Interim Controller Handbook.

RATT Messages --- This activity pattern subsumes any combination of the performances involved in the development, receipt, and/or management of RATT messages.

Performances in this pattern include the following:

1. attending to a RATT message that appears on the A/N monitor.

2. pressing buttons (keys) on the A/N keyboard to create or transmit a RATT message.

3. communication to the controller managing the A/N keyboard in which the creation and/or transmission of a RATT message is requested.

4. tasks 37–39, 47, and 48 in the Interim Controller Handbook.

Alert Messages --- This activity pattern is represented by any combination of the performances of the controller involved in the receipt, saving (storage), recall, printing, and/or deletion of alert messages received on the A/N monitor.

Performances representing this activity pattern include the following:

1. attending to alert messages that are displayed on the A/N monitor.

2. use of the A/N keyboard and A/N monitor to delete, save, recall, or print an alert message.

3. communications to the controller managing the A/N keyboard in which the deletion, storage, recall, or printing of an alert message is requested.

4. tasks 41-44 in the Interim Controller Handbook.

Special Status Reports --- In this category are included any combination of the performances of the controller involved in eliciting, reading, and/or deleting special status reports on the A/N monitor.

Performances representing this activity pattern include the following:

1. attending to a special status report displayed on the A/N monitor.

2. use of the A/N keyboard and A/N monitor to call up or print a special status report on the A/N monitor.

3. reading a printed special status report.

4. communication to the controller managing the A/N keyboard in which the elicitation or printing of a special status report is requested.

5. task 40 in the Interim Controller Handbook.

Command and Control Inputs --- This pattern includes any combination of the performances of the controller involved in making a command and control input.

Performances representing this activity pattern include the following:

1. use of the graphic monitor and analogue pen to make a command and control input.

2. communications with the controller entering command and control inputs in which a controller either supplies information about a command and control input or requests that a command and control input be made.

15-Minute Status Report --- This activity pattern is represented by any combination of the performances of the controller involved in the acquisition of information from a 15-minute summary.

This activity pattern is represented by such performances as the following:

1. reading a 15-minute status report.

2. communications in which a controller requests access to or information from a 15-minute status report.

Monitor the Situation --- This activity pattern includes any combination of performances of the controller involved in either or both (a) monitoring any communication in which he is not a participant and (b) displaying and attending to the graphic monitor except for the purpose of making command and control inputs.

In this research, Monitor the Situation is considered to be the "steady-state" performance of a controller so that in the absence of performances indicating another performance category (i.e., activity pattern), the controller is likely engaged in performances representing this activity pattern.

Communications Data

During the training exercises, the following data were collected about each communication of the player CO and/or S3 with the observed controllers in their roles as forward team commanders:

1. time of communication --- the game time in minutes in which the communication was initiated.

2. communications net --- the radio or telephone channel over which the communication was transmitted.

3. initiator of communication --- the person by role (that is, player or controller) who initiated the communication.

4. role of player --- the position(s) of the player(s) in the command group (that is, the CO and/or S3) involved in the communication.

5. player requested information --- whether the player requested information of any type from the controller or requested/directed/commanded the controller (in his role as subordinate team commander) to take actions to acquire information.

6. controller provided information --- whether the controller (in the relevant military role) described events in the tactical operation or relayed a decision, request, conclusion, inference, etc., relevant to the tactical situation.

7. controller sought information during the communication --- whether after a communication had been initiated, the controller sought information bearing on the communication from one of the information sources available to him (graphics, alerts, special status reports, 15-minute summaries, a player not directly involved in communication, another controller, or his notes).

8. computer down times --- game time in minutes at which the math model halted computation because of an apparent malfunction in the computer system and the length in minutes of interrupted calculation.

.rocedural Instructions

The observers had been oriented to the CATTS systems. Prior to the start of an exercise, they also attempted to become familiarized with the operation plans/orders for the exercise. Otherwise, the observers were guided by the following instructions in collecting observational data on activity patterns and controller-to-player communications:

1. Monitor all the behaviors of the controller in all of the military roles played by him in order to identify the activity pattern that best describes his performance at a given point during the exercise and to chart the changes in his activity patterns throughout the exercise.

2. The activity patterns that could describe the performance of the controller at any point of the exercise have been defined earlier. When the controller is engaged in any combination of the performances representing the activity pattern, his performance is described by that activity pattern.

a. All activity patterns, with the exception of Monitor the Situation, tend to be represented by overt performances. Use the overt performances to determine which activity pattern best describes the controller's performance.

b. If the controller does not exhibit performances representing an activity pattern, his performance is to be classified as Monitor the Situation.

3. A controller may appear to be engaged in more than one activity pattern at the same time.

a. The following types of overlaps in activity patterns appear to be most likely:

(1) the controller is engaged in one of the communication activity patterns and a non-communication activity.

(2) the controller is engaged in Monitor the Situation and another activity pattern.

b. The controller's performance is to be classified in the communication activity pattern when performances representing this pattern overlap with any non-communication performance.

c. If the controller's performances are such that they could be classified as representing either Monitor the Situation or another activity pattern, his performance at that time is to be classified as representing the other activity pattern.

4. A controller's activity pattern changes when the performances representing one pattern terminate and then the performances exemplifying a new pattern are exhibited.

a. Accordingly, the general ruie is that an activity pattern does not change until performances representing one activity pattern cease and those representing another pattern are initiated.

b. The general rule just presented for identifying changes in activity patterns holds except for those instances in which the performances representing one activity pattern have terminated and are not followed by overt performances representing another

pattern. In such instances, the controller's activity pattern changes to Monitor the Situation.

5. If an activity pattern is interrupted or broken by performances representing another activity pattern, the controller's activity pattern has changed from the original activity pattern to the one that interrupted it. If performances representing the broken pattern are resumed, the controller's activity pattern has again changed back to the original one.

6. Use the checklist provided to chart the sequences of the controller's activity patterns[1]. Chart the changes that occur until performances representing Communications with the Player CO and S3 via Radio and Telephone occur.

7. For each Communication with the Player CO and S3 via Radio and Telephone, respond to the items on the communications observation form. The items on the communications observation form were defined earlier.

8. Between each communication with the player CO and S3, continue to chart the activity patterns of the controller.

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[1] The collection form for data on activity patterns was used as follows: (1) numbers were recorded from left to right in the cells next to an activity pattern to indicate the sequence in which activity patterns occurred; (2) the game time was used to indicate the first activity pattern, and successive integers beginning with 2 were used to indicate each successive activity pattern until a communication with the player CO/S3 occurred; (3) after the communication terminated, charting was resumed as just described in (2). Thus, activity patterns during communications were not necessarily recorded.

Attachment 1 to Appendix B:
Tasks from Interim Controller Handbook[2]

Task 37

Transmit a "canned" message to the trainee via RATT.

To complete this task the following sequence of operations must be performed:

1. Depress the RATT ON/OFF A/N function key.
2. Read the instructions which appear on the A/N CRT.
3. Type in the CATALOG NUMBER of the canned message.
4. Edit the message if this is required.
5. Position the A/N cursor at the far left on the line immediately following the last line of the message.
6. Depress the ON LINE A/N function key.
7. Depress the RATT ON/OFF A/N function key.
8. Read the instructions that appear on the A/N CRT.
9. Type in the instruction SEND.
10. Depress the NEW LINE A/N function key.

Task 38

Transmit the current ALERT message to the trainee via RATT.

To complete this task the following sequence of operations must be performed:

1. Depress the RATT ON/OFF A/N function key.
2. Read the instructions which appear on the A/N CRT.
3. Type in the instruction ZERO.
4. Edit the message if this is required.
5. Position the A/N cursor at the far left on the line immediately following the last line of the message.
6. Depress the ON LINE A/N function key.
7. Depress the RATT ON/OFF A/N function key.
8. Read the instructions that appear on the A/N CRT.
9. Type in the instruction SEND.
10. Depress the NEW LINE A/N function key.

---

[2]The task statements are taken directly from the Interim Controller Manual: Draft (October 1974) prepared by personnel from the Columbus Office of HumRRO in conjunction with the CATTS Directorate.

Task 39

Transmit an original message to the trainee via RATT.

To complete this task the following sequence of operations must be performed:

1. Depress the RATT ON/OFF A/N function key.
2. Read the instructions which appear on the A/N CRT.
3. Type in NONE.
4. Type in the original message.
5. Position the A/N cursor at the far left on the line immediately following the last line of the message.
6. Depress the ON LINE A/N function key.
7. Depress the RATT ON/OFF A/N function key.
8. Read the instructions that appear on the A/N CRT.
9. Type in the instruction SEND.
10. Depress the NEW LINE A/N function key.

Task 40

Call up a special status report for a designated unit.

To complete this task the following sequence of operations must be performed:

1. Depress the SPECIAL STATUS REPORT key on the A/N Keyboard.
2. Type in the unit name and designation.
3. Depress the NEW LINE key on the A/N Keyboard.

Task 41

Recall an ALERT message.

To complete this task the following sequence of operations must be performed:

1. Depress the SCAN key on the A/N Keyboard.
2. Observe the current message block on the A/N CRT.
3. Wait until the desired ALERT message appears in the current message block on the A/N CRT and then perform the desired operation (Drop or Print).
4. Depress the SCAN control to return conditions to the state they were in prior to first activating the SCAN key.

Task 42

Delete a message displayed on the A/N CRT.

To complete this task the DROP key on the A/N Keyboard is depressed.

Task 43

Save a current ALERT message.

To complete this task the SAVE key on the A/N Keyboard is depressed.

Task 44

Print a message displayed on the A/N CRT.

To complete this task the PRINT key on the A/N Keyboard is depressed.

Task 47

Create a "canned" RATT message.

To complete this task the following sequence of operations must be performed:
1. Type in the instruction SAVE.
2. Depress the NEW LINE A/N function key.
3. Responding to the computer generated message asking about the message's assigned CATALOG NUMBER, type in the CATALOG NUMBER.
4. Depress the NEW LINE A/N function key.

Task 48

Instruct the computer to Forget a Message Entered on the A/N CRT.

To complete this task the following requirements of operation must be performed:
1. Type in the instruction FORGET
2. Depress the NEW LINE A/N function key.

Task 50

Communicate via radio.

To complete this task the following sequence of operations is performed:
1. Engage the MONITOR control corresponding to the channel on which the communication is to occur.
2. Depress the TRANSMIT MOMENTARY PUSHBUTTON in the desired mode of communication (clear or secure) which corresponds to the channel on which communication is to be conducted.

Task 50 Cont'd

3. Depress the transmission foot pedal to transmit.
4. Transmit your message according to Army SOP.
5. Release the transmission foot pedal to receive.
6. Continue the transmission/reception sequence until communication has been established or it is determined that the transmission can not be completed.

Task 53

Communicate from a Controller Console via telephone/intercom with a trainee or controller/aide.

To complete this task the following sequence of operations must be performed:

1. Depress the console INCOMING/OUTGOING pushbutton control.
2. Employ the TELEPHONE DIALING PUSHBUTTONS to dial the code corresponding to whom it is desired to communicate.
3. If the called station's telephone/intercom is in use, a busy tone will be heard for 5 seconds, after which the dialing procedure is again initiated.
4. Continue the dialing sequence until communication has been established or it is determined that the communication cannot be completed.

Task 54

Receive a communication from another controller/aide via Telephone Intercom

To complete this task depress the INCOMING/OUTGOING pushbutton.

Task 55

Receive a communication from a trainee via telephone.

To complete this task the following sequence of operations must be performed:

1. Depress the console INCOMING/OUTGOING control.
2. Employ the TELEPHONE DIALING SWITCHES to dial the trainee's dialing code.

Task 56

Clear a Telephone Circuit.

To complete this task depress the CLEAR control on the console.

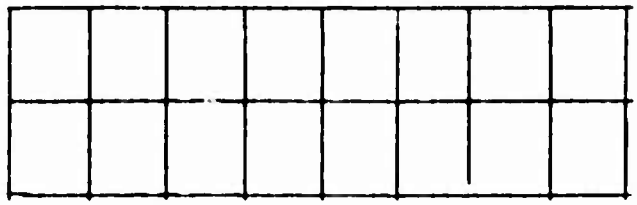
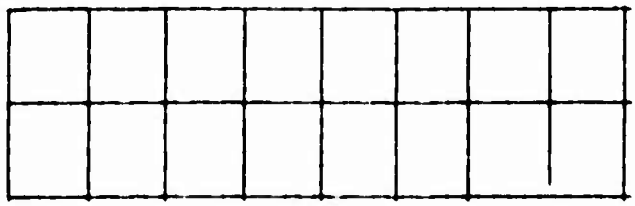
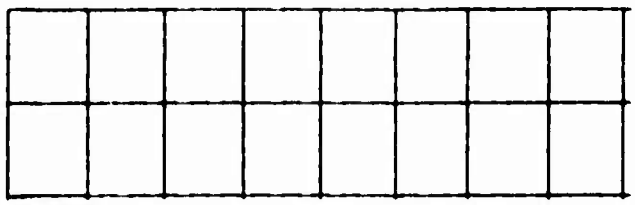
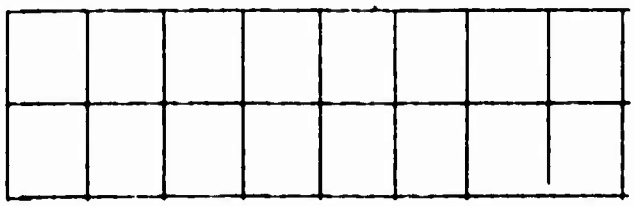
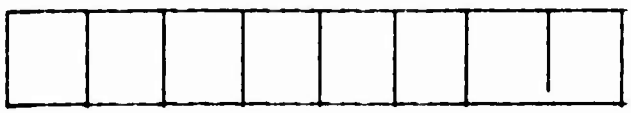
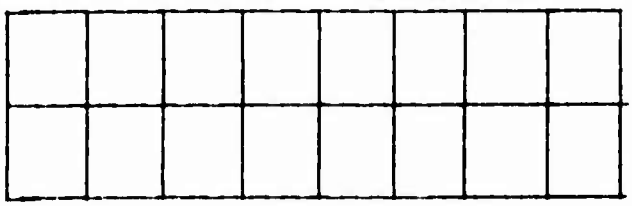
Task 57

Switch an Incoming Telephone Transmission.

To complete this task the following sequence of operations must be performed:

1. Depress the switchboard INCOMING/OUTGOING pushbutton.
2. Accept the request for connection to another (other) individual(s).
3. Employ the TELEPHONE DIALING SWITCHES to dial in the dialing code for the individuals with whom it is desired to communicate.
4. Depress the CLEAR control on the console.

Controller-to-Player Communications:
Collection Form for Activity Patterns

ACTIVITY PATTERN		SEQUENCE
Monitor Situation		
Commo with Player/ Controller (other than CO & S3		
Alert Messages		
Spec Status Rpts	Blue	
	Red	
Ratt Messages		
15 Min Sum		
Command & Control Inputs		

Controller-to-Player Communications:
Collection Form for Communications Data

Game Time: _____

Commo Net:	Bn Comd Net	_____	Telephone	_____
	Other Radio	_____	Telephone	_____
Initiator:	Player	_____		
	Controller	_____	Canned:	_____
Role of Player:	Bn CO	_____		
	Bn S3	_____		
Player Requested Info:		_____		
Controller Provided Info:		_____		
Controller Sought Info during Commo:	Graphics	_____	Another Player	_____
	Alerts	_____	Controller	_____
	Spec Status	_____	Controller Notes	_____
	15-min Sum	_____		
Computer Down Time:	Game Time:	_____		
	Mins Down:	_____		

Controller-to-Player Communications: Content Analysis Procedures

General Approach

During two training exercises, each of two controllers serving as forward team commanders were observed in order to collect data on their communications to players and the relationship of their communications to outputs of the computer (see Controller-to-Player Communications: Observation Procedures). These communications were also tape recorded. Later, the two observers independently analyzed the communications in order to collect more complete data in terms of the following

---the items of information communicated to players by controllers in their military roles.

---the computer output sources that appeared to provide the information communicated to players.

---the ways in which computer-generated information was transformed in communicating it to players.

The guidelines for the content analysis are presented next.

Content Analysis Guidelines

1. The tape-recorded (and/or transcribed) communications are to be reviewed in their order of occurrence.

a. As used here, a communication consists of all the verbal dialogue that takes place between the initiation and termination of a radio or telephone call to one or more participants in CATTS.

b. The communications selected for analysis are to be analyzed in the sequence of their occurrence on the tape (or transcript), i.e., as they occurred during the exercise. However, review all communications that took place prior to each communication before analyzing it.

c. The following materials are to be available during the review:

(1) print outs of alert messages generated during the exercise,

(2) print outs of all 15-minute summaries provided during the exercise.

(3) forms on which the activity patterns of the controllers had been recorded,

(4) the listing of computer outputs,

(5) copies of the form for recording judgments about selected communications,

(6) a listing of the communications to be analyzed, and

(7) code sheets of the tape recordings.

2. For each communication selected for analysis, data like that collected during the exercise are to be recorded. These data are as follows:

a. Initiator of communication

(1) the intitator is the role or person (controller or player) referenced by the call sign of the initiator of the transmission.

(2) indicate whether the player or controller was the initiator.

b. Role of player

(1) the role(s) of the player(s) involved in the communication are the role(s) referenced in the call sign(s) of the player(s) in the communication.

(2) indicate whether the Bn CO, S3, or both were referenced in the communication.

c. Player requested information

(1) a player requested information during the communication if he requested the controller for information of any type or if he requested/commanded/ordered the controller to take actions to acquire information.

(2) place a check mark in the blank on the analysis form if a player requested information.

d. Controller provided information

(1) the controller provided information to the player if during the communication, he described events in the tactical operation or if he relayed a decision, request, conclusion, inference, etc., relevant to the tactical situation.

(2) place a check in the appropriate blank if the controller provided information to the player.

e. Player directed action

(1) the player directed action during the communication if he directly requested/commanded the controller to do something with respect to the tactical situation or if he announced a decision that implied actions for the controller in his role as forward company/team commander.

(2) place a check in the appropriate blank to indicate whether the controller directed action.

3. After recording the data described in paragraph 2, the computer output sources on which information provided to players by controllers was potentially based are to be identified. This will involve three steps.

a. First, identify and record the separate topics or items of the information provided to a player by a controller in a communication. Record as many separate items as you judge are contained in the communication.

b. Second, for each item in the communication, make an identification of the computer outputs (if any) that, in your judgment, appear to be reflected in it.

(1) outputs of the computer are reflected in a communication under one or both of two conditions: first, the communication of the item directly expresses all or part of one or more computer outputs or, second, the communicated item represents information (e.g., conclusion, implication) that could have been at least partly derived or formed from one or more outputs.

(2) the attached list[3] summarizes output from the computer. Use the listed outputs and other unlisted outputs to determine the outputs reflected in the item.

c. Third, for each item that appears to reflect one or more computer outputs, determine the potential source(s) of the outputs. For the purposes of this study, there are four possible sources of a computer output: graphics (g), alert messages (a), special status reports (s), and 15-minute summaries (15).

(1) to make this determination, consider each output that you believe to have been reflected in the communicated item. Use the attached list of computer outputs and your knowledge of the system to make a tentative identification of the source(s) --- g, a, s, and/or 15 --- that could have provided the outputs reflected in the communication.

(2) based on this identification, use the controller's activity pattern forms and computer printouts of alerts to determine whether he had consulted each of the potential sources of an output.

(3) if the possible source of an output was graphics and if the controller engaged in the activity pattern related to graphics during the <u>five-minute period preceding communication</u> of the subject, it will be assumed that the controller potentially had access to the relevant output(s) through graphics. Under this condition, record <u>g</u> beside the subject to indicate that graphical information was a potential source of the output(s) reflected in the communication.

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[3]Attachment 2 to Appendix <u>B</u>.

(4) if alert message(s) was (were) a likely source of an output reflected in a communication, it will be assumed that the controller had access to the output if within the five-minute period preceding the communication both the relevant alert message(s) was (were) displayed and the controller engaged in the activity pattern related to alerts. Thus, record a beside the item to indicate that alert message(s) was (were) a source of the output if two conditions are met: first, the controller engaged in the alert activity pattern during the five-minute period preceding the communication and, second, through a search of the printed alerts, you find one or more relevant alert messages that had been displayed during the same period.

(5) record s beside the item to indicate that a special status report was a likely source if the controller engaged in the activity pattern related to special status reports during the five-minute period preceding the communication.

(6) record 15 beside the item to indicate that the 15-minute summary(ies) had been a likely source if the controller had engaged in activities related to 15-minute summaries within a period of 15 minutes prior to the communication and if a summary available during that period (i.e., printed prior to the communication) contained the relevant information.

(7) according to the above procedures, more than one source may be recorded for each item.

(8) if based on the above procedures, it does not appear that the controller consulted a relevant source for an output, record No beside the item.

4. Identify ways in which the controller altered information in computer outputs in communicating to the players.

a. to identify alterations, compare the outputs (reflected in a communication) as presented by the computer to the controller's communication in which the outputs were reflected.

(1) if the source of the output(s) was alerts and/or 15 minute summaries, read the relevant outputs actually provided by the computer (as identified through the procedures described in paragraph 3) in conjunction with the communication.

(2) if the source was graphics and/or special status reports, recall to the extent possible the manner in which the information expressed in the communication would have been displayed on the graphic monitor or in the special status report in the five-minute period preceding the communication.

b. Review all outputs related to a communication. Then judge which (if any) of the following describe differences between any of the outputs and the related information transmitted in the communication:

(1) form alteration --- the information communicated to the player was essentially the same in denotative meaning as the output; however, it was expressed in a different manner or form. For example, the controller accurately transmitted information supplied by the computer but added expressive qualifiers

(e.g., "I'm in real trouble; I have lost ___ number men.") that did not supply additional (in terms of type or detail) information about the tactical situation.

(2) altered detail --- the information in the communication was not at the same level of detail as that in the computer. Examples of differences in detail are: model outputs described platoons whereas the controller reported information about companies (or vice versa); a computer output described the types of equipment lost whereas the controller reported only that "equipment" was lost; or the model depicted a red platoon against a blue unit whereas the controller communicates the number and type of personnel and equipment in the red platoon.

(3) deletion of information --- the computer output(s) consulted by the controller provided information about parameters not transmitted to the player(s). An alert message, for example, might indicate the rate at which a unit is moving whereas the controller communicated only that the unit "is moving".

(4) addition of information --- the outputs consulted by the controller provided the types of information communicated to the player; however, the controller added information about variables not represented in the output itself. Based on graphic information, for example, the controller might report the sighting of a red unit. In addition, he reports that the platoon is "dug in", information not provided by the graphic monitor.

c. List any of the alterations detected in a communication. Beside the alteration, cite the subjects in which the output was altered.

Attachment 2 to Appendix B:
Summary of Computer Outputs

1. location of FRONT-LINE TRACE (g)
2. location of OBSTACLE (g, a)
3. reaching an OBSTACLE and/or delays caused by it (g, a)
4. entering a MINEFIELD and/or losses incurred (g, a, s)
5. location of a UNIT (g, a, s, 15)
6. AREA OCCUPIED by a unit (g)
7. location of COMMAND POST (g)
8. DIRECTION OF MOVEMENT of a unit (g)
9. changes in a unit's RATE AND/OR MODE of travel (a, s)
10. location and/or coverage of GROUND RADAR DEVICES (g)
11. location and/or coverage of GROUND SENSORS (g)
12. location and/or coverage of OBSERVATION POST (g)
13. location and/or coverage of NIGHT VISION DEVICES (g)
14. location and/or coverage of AIRBORNE SENSORS (g)
15. VISUALLY DETECTING a unit at a designated location/time (a)
16. RADAR DETECTION of a unit at a designated location/time (a)
17. DETECTION of a unit at a designated location/time by UNATTENDED GROUND SENSORS (a)
18. DETECTION of a ground unit by an AIR UNIT (a)
19. positions of ANTITANK ROCKETS (g)
20. positions of antitank MISSILES (g)
21. positions of ARTILLERY WEAPONS (g)
22. positions of AIR DEFENSE WEAPONS (g)
23. positions of MORTARS (g)

24. RECEIPT OF DELIVERY of FIRES from a unit (g, a)

25. of AIR STRIKES (g)

26. AIR UNIT's RECEIVING FIRE from being HIT by ground unit (a)

27. FIRING at an AIR UNIT (a)

28. CEASE FIRE at air unit (a)

29. unit's DELIVERY OF ORDANCE on a designated unit at designated location/time (a)

30. firing ARTILLERY at designated location/time (a)

31. CASUALTY report (a)

32. CASUALTIES due to AIR STRIKE (a)

33 ROAD DAMAGE (a)

34. BRIDGE DAMAGE (a)

35. READINESS CONDITION of a unit and the reasons for it (a, 15)

36. DESTRUCTION OF CP and/or commo loss with unit (a)

37. RESTORATION OF COMMO with CP HQ

38. STATUS OF AMMO (a, s, 15)

39. STATUS OF FUEL (a, s, 15)

40. STATUS OF EQUIPMENT (a, s, 15)

41. STATUS OF PERSONNEL (a, s, 15)

42. change in STATUS OF AIR UNIT (e.g., on ground) (a)

43. report of RESUPPLY (a, s, 15)

44. location of CONTROL MEASURES (g)

45. violation of CONTROL MEASURE (a, g)

46. crossing of CONTROL MEASURE (a, g)

47. WEATHER CONDITIONS (a)

48. percent SUPPRESSION of a unit (15)

Controller-to-Player Communications:
Form for Analysis of Content of Communications

Communication No. _____

Initiator Player _____ Role of Player Bn CO _____

Controller _____ Bn S3 _____

Player Requested Info _____ Controller Provided Info _____ Player Directed Action _____

Subjects in Information Provided to Players & Sources:

Alterations (Form, Detail, Deletion, Addition)

Misrepresentation Yes _____

No _____

Table B-1

Frequency of "Information Sought During Communications": Observation Data[a]

Source of Information Sought	LEFT CONTROLLER			RIGHT CONTROLLER			
	Defense	Attack	Total	Defense	Attack	Total	TOTAL
Graphics	32	28	60	24	17	41	101
Alerts	4	7	11	1	15	16	27
Spec Status	9	7	16	0	4	4	20
15-Min Sum	0	0	0	0	0	0	0
Another Player	0	0	0	0	0	0	0
Controller	0	1	1	3	3	6	7
Controller Notes	2	4	6	14	11	25	31

[a]Table entries represent the number of times that each information source was consulted after a communication had been initiated. More than one source was often sought. Consequently the total is greater than the number of communications. There were 162 communications recorded by the observers. Information was not sought during 41 of the 162 communications.

Table B-2

Items Communicated in Defense

by Left Controller: Content Analysis

Graphics (G)

Red Incoming (Arty) Fires (2)[a]
Red Incoming (Air) Fires (1)
Red Location/Movement (2)
Red Location (5)

Blue Air Strike (2)
Blue Location (4)
Blue Supporting Fires (1)
Blue Movement (1)

Alert (A)

None.

Special Status Report(S)

Red Location/Strength/Composition (1)

Blue Unit Status (1)
Effects of Blue Air Strike (1)

G&A

Red Incoming (Arty) Fires (1)

Effects of Blue Supporting (Arty) Fires (1)

G&S

Red Unit Status (3)
Red Location/Movement (3)
Red Incoming (Arty) Fires (1)

Blue Unit Status (5)
Blue Air Strike Status (1)
Blue Location (5)
Blue Movement (1)

A&S

None.

A&G&S

Red Location/Movement (1)

Blue Unit Status (1)

Fabrication

Effects of Smoke (1)

Effects of Dust (1)

[a]The number in parentheses represents the frequency that the subject was communicated after the source(s) had been consulted.

Table B-3

Items Communicated in Defense

by Right Controller: Content Analysis

Graphics (G)

Sightings of Red APCs (1) [a]
Red Movements (3)
Red Location (2)
Red Air Strike (1)
Blue Location (6)
Blue Movement (1)

Alert (A)

Red Movement (1)

Special Status Report (S)

Blue Personnel Status(1)
Blue Personnel & Equipment Status (2)

G&A

Red Incoming (Arty) Fires (1)
Blue Location (1)

G&S

Red Unit Equipment Status (1)
Red Location (1)
Blue Personnel & Equipment Status (1)

A&S

None

A&G&S

Blue Personnel Status (1)
Blue Personnel & Equipment Status (1)
Blue Personnel, Equipment, and Location Status (1)

Fabrication

None.

[a]The number in parentheses represents the frequency that the subject was communicated after the source(s) had been consulted.

Table B-4

Items Communicated in Attack

by Left Controller: Content Analysis

Graphics (G)

Red Strength (1)[a]
Red Air Strike (1)
Red Tanks Location & Strength (4)
Red Mortars (1)
Red Movement (2)
Red Incoming Fires (12)
Blue Unit Location (7)
Blue Obstacle (1)
Blue Air Strike (4)
Blue Movement (1)

Alerts (A)

Blue Unit Status (1)

Special Status Report(S)

Blue Equipment Loss (1)

G&A

Red Location (1)
Blue Location/Equipment Status (9)
Blue Movement (1)
Blue Contact With Red (1)

G&S

Red Tanks Location & Strength (1)
Red Location/Strength (1)
Blue Unit Status (5)

A&S

None.

A&G&S

Red Location/Strength (4)
Red Location (1)
Blue Location/Status (12)

Fabrication

Minefield Lane Breeched (1)

[a]The number in parentheses represents the frequency that the subject was communicated after the source(s) had been consulted.

Table B-5

Items Communicated in Attack

by Right Controller: Content Analysis

Graphics (G)

Red Location (2)[a]
Red Movement (1)
Blue Location (4)
Blue Movement (1)

Alert (A)

Red Air Strike (1)
Red Location/Strength Disposition (1)
Blue Personnel Losses (3)
Blue Equipment Losses (1)

Special Status Report(S)

None.

G&A

Red Incoming (Arty) Fires (3)
Red Small Arms Fires (1)
Red Incoming Fires (Air Strike)(2)
Red Location/Disposition (2)
Blue Location (2)
Blue Location/Movement (5)
Blue Personnel Losses (5)
Blue Equipment Losses (5)

G&S

Blue Status (2)
Blue Movement (1)
Blue Location (1)

A&S

Red Unit Status (1)
Blue Ammo Status (1)

A&G&S

None.

Fabrication

None.

[a]The number in parentheses represents the frequency that the subject was communicated after the source(s) had been consulted.

Table B-6

Transformed Items Communicated in Defense

by Left Controller: Content Analysis

Form

Blue Location (6)[a]
Blue Air Strike (1)
Blue (Pers/Equip) Status (6)
Red Location (6)
Red Movement (6)
Red Strength (2)
Red Composition (2)
Blue Movement (2)
Blue Arty Adjustment (1)

Detail

None

Deletion

None

Addition

Adjustment of Fires (1)
Blue (Pers/Equip) Status (1)
Effects of Dust (1)

Form/Detail

Red Incoming (Arty) Fires (8)
Blue Location (6)
Red Location (6)
Blue Supporting (Arty) Fires (4)
Red Air Strikes (1)
Red Movement (3)
Blue Status (3)
Blue Air Strike (2)
Red Strength (2)
Blue Task Reorganization (1)
Blue Movement (1)

Form/Addition

Red Incoming (Arty) Fires (1)
Blue Location (4)
Blue (Pers/Equip) Status (2)
Red Location (3)
Red Strength (4)
Blue Air Strike (2)
Blue Movement (1)

Form/Detail/Addition

Red Movement (2)
Red Location (2)
Red Strength (1)
Red Resistance (1)
Blue Location (1)
Blue Strength (1)
Blue Movement (2)
Blue Air Strike (1)

---

[a]The number in parentheses represents the frequency that the item was judged to have been transformed.

Table B-7

Transformed Items Communicated in Defense

by Right Controller: Content Analysis

Form

Blue (Pers) Status (2)[a]
Red Incoming (Arty) Fires (1)
Blue (Pers/Equip) Status (3)
Blue Location (5)
Red Location (2)
Red Movement (1)
Blue Movement (1)

Detail

None

Deletion

Blue (Pers/Equip) Status (1)

Addition

None

Form/Detail

Blue Location/Movement (1)
Red Location/Movement (2)
Red Movement (1)
Red Air Strike (1)
Red (Equip) Status (1)
Blue Location (1)
Blue (Pers/Equip) Status (1)

Form/Addition

Red Incoming (Arty) Fires (2)
Blue (Pers/Equip) Status (1)
Blue Location (1)
Red Location/Movement (1)

---

[a]The number in parentheses represents the frequency that the item was judged to have been transformed.

Table B-8

Transformed Items Communicated in Attack

by Left Controller: Content Analysis

Form

Blue Location (21)[a]
Red Obstacle (1)
Red Air Strike (1)
Blue (Equip) Status (13)
Blue (Pers) Status (15)
Red Location (8)
Blue Air Strike (2)
Blue Supporting Fires (2)
Blue Movement (1)
Blue (Ammo) Status (2)
Red Incoming (Arty) Fires (2)
Blue (Fuel) Status (1)

Detail

Blue Location (1)
Blue (Pers) Status (1)
Red Location (1)
Red Strength (1)
Red Incoming Fires (1)

Deletion

None

Addition

None

Form/Detail

Blue Air Strike (2)
Red Location (5)
Blue (Ammo) Status (1)
Blue Location (6)
Blue (Pers/Equip) Status (5)
Red (Pers) Status (1)
Red Incoming (Ground) Fires (1)

Form/Addition

Red Location (2)
Blue (Equip) Status (2)
Blue Movement (2)
Red Minefield (1)
Blue (Pers) Status (2)
Blue Location (1)

Form/Detail/Addition

Red Minefield (1)
Blue Air Strike (1)
Blue Location (1)
Red Incoming Fires (1)

---

[a]The number in parentheses represents the frequency that the item was judged to have been transformed.

Table B-9

Transformed Items Communicated in Attack by Right Controller: Content Analysis

Form

Blue (Pers) Status (7)[a]
Red Air Strike (2)
Blue Location (5)
Blue Movement (4)
Blue (Equip) Status (5)
Blue Task Reorganization (1)
Blue Reserve (1)

Detail

None

Deletion

None

Addition

Red Location (1)
Red Disposition (1)

Form/Detail

Blue Location (3)
Red Obstacle Minefield (1)
Red Incoming (Arty) Fires (1)
Blue Supporting (Arty) Fires (1)
Blue Movement (1)

Form/Addition

Red Air Strike (1)
Blue (Pers) Status (2)
Blue (Equip) Status (3)
Blue Location (4)
Blue Movement (3)
Red Movement (1)
Red Location (3)
Red (Pers) Status (1)
Red Incoming (Arty) Fires (1)
Blue Supporting (Arty) Fires (2)

Form/Detail/Addition

Red Incoming (Arty) Fires (1)
Blue (Pers) Status (1)
Blue (Equip) Status (1)
Blue Location (1)
Red (Pers) Status (1)
Red (Equip) Status (1)
Blue (Ammo) Status (1)
Blue Task Reorganization (1)

[a]The number in parentheses represents the frequency that the item was judged to have been transformed.

APPENDIX C

CONTROLLER QUESTIONNAIRE

This appendix contains the questionnaire administered to controllers. Instructions introducing the questionnaire are presented first. The job positions of responding controllers are described next. Questionnaire items and summaries of responses to them are presented last. There are two major variations in manner in which responses were summarized. The number of controllers selecting alternative responses and, where appropriate, the median responses of controllers at each console are provided for structured items. For each open-ended question, the number of controllers responding is indicated. In addition representative responses were developed from the controllers' actual statements. After each representative summary, the number and type of controllers making the response are designated. To designate the latter, a numeral is used to specify the number of controllers making the response; the letters B, R, or A are used to denote whether the controller was a blue controller (that is, positioned at either the forward company or fire support console), a red controller (that is, all controllers at the aggressor console) or an administrator (for example, the chief controller). It should be noted that in summarizing responses to open-ended questions, one frequent type of response was ignored because it failed to address the issue. This type of response suggested that a particular type of controller problem (for example, inability to know the exact status of a unit) actually confronts individuals assuming the controllers' military roles in battle and, therefore, is realistic. As such responses were ignored, the total number of controllers citing the responses summarized for a question is not always as great as the total number of controllers providing responses to it.

INSTRUCTIONS

During the period of system definition research, ARI has conducted a preliminary study of the flow of information in training exercises. ARI's study was designed in terms of two questions about the CATTS system:

(1) In what manner is the information communicated by controllers to players about the tactical operation related to outputs of the computer?

(2) To what extent are players' decisions, announced during the execution of their tactical operation plans, enacted through the computer?

Player - to - controller communications and controllers' interactions were observed in order to collect data related to the two questions. Information processing, however, is not a completely observable process. Consequently, you are being asked to respond to the items in this questionnaire so that more complete data on information flow in the system can be collected.

The data collected in this study will be analyzed in order, first, to describe information flow in training exercises during system definition research and, second, to formulate recommendations regarding future developments of the CATTS system. Because of the latter, many of the items in this questionnaire concern problems or difficulties that you may have experienced in controlling training exercises.

It should be noted that the items in this questionnaire regard the "training exercises during system definition research." That is, the questions pertain to the FEBA GOLD, SILVER, and ATTACK exercises for the last five training groups. In this manner, the research focuses on use of the system after it had been prepared for training and display.

In responding to the questions, follow these general guidelines:

(1) Indicate below the console position that you played most consistently in training exercises during system definition research. If you occupied a blue controller position, list the various military roles that you played; indicate which of these roles was your principal military role. You are to respond to most items in the questionnaire in terms of your most consistent console position. For other items, you will be asked to respond in terms of your principal military role.

(2) Each of you are to answer the questions independently of the other members of the CATTS Directorate. We are interested in the variety of views that may exist. If you need clarification regarding any aspect of the questionnaire, call Trueman Tremble at 545-5392.

(3) Take as much time as needed to respond to the questionnaire. Space has been provided for your answers. It is quite possible, however, that you may need additional space for several items. If so, use the blank sheets that have been attached at the end of the questionnaire. In carrying responses over to these sheets, please clearly label the questions that you are responding to.

(4) At times, you may feel that you are providing the same or very similar information in response to several items. If the same information is appropriate for several items, be sure to repeat it. If, however, you feel that you do not understand differences between items, seek clarification from the aforementioned.

(5) One term used in the questionnaire needs to be clarified at this point. The term is "initiate command and control inputs". This term is used to refer to your activities involved in making command and control inputs regardless of your position. Thus, if you occupied an end position, you tended to initiate command and control inputs by communicating the appropriate information to the controller at a center position. Controllers at center positions operated the input mechanisms as well.

Thank you for your effort. If you have questions, please call to seek clarification.

DESCRIPTION OF RESPONDENTS

Forward Company Console (N=3)

Console Positions: Two respondents at left-end position; one respondent at center position (command-and-control input operator).

Military Roles: All respondents assumed roles of leaders and commanders of subordinate-level forward units (blue forces).

Fire Support Console (N=3)

Console Positions: One respondent at each console position.

Military Roles: One respondent assumed the role of forward observer for mortar and artillery support activities of blue forces. One respondent served as flight lead and the direct air support center (blue forces). The third respondent played artillery support roles and the activities of the heavy mortar fire direction center (blue forces).

Agressor Console (N=4)

Console Positions: Two respondents at left-end position; one respondent at center position; one respondent at right end position.

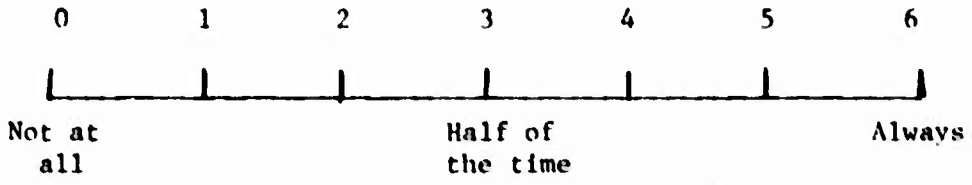
Military Roles: Two respondents served in both brigade, adjacent, and ADA roles (blue forces). Two respondents managed red forces.

Administrative (N=2)

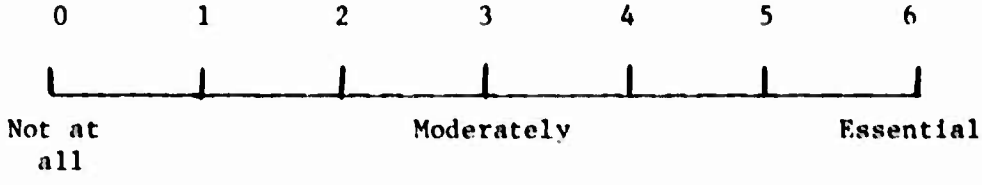
One respondent was the "chief" controller who also served as the Brigade Commander (blue forces). The other respondent had research responsibilities and usually monitored exercises from the observer station.

1. On the following pages are listed items of information which were displayed on the graphic CRT. Read each item of information, and consider the various ways in which you used it in the "typical" training exercise during system definition research. Then answer the following questions about each item by selecting the appropriate numbers on the scales below the questions:

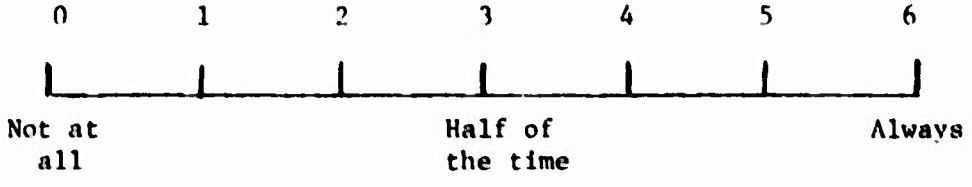
   a. How often did you make use of this information?



   b. How important was this information to you in your role as a controller?



   c. Compared to the extent that you used this information as a controller, how often was it reflected in your communications to a player?



   Place your responses for an item in the spaces to the left of it on the following pages.
   Recall to select your responses in terms of the typical CATTS training exercise.
   Answer the questions from the perspective of your principal military role as a controller if you were a blue controller.
   Answer the questions in terms of the "mixture" of roles that you played if you were a red controller.

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
1. --- map grid coordinates	2	5	2.5	2	5	5	.2	2	2.5
2. --- tactical overview	1	4.8	4	.8	5	3.5	.2	4	2.5
3. --- RED obstacles	5	3.2	5.5	4.5	3	4.5	3.2	3	1.5
4. --- BLUE obstacles	5	5.8	5.5	5	5.8	4.5	1.5	3	2
5. --- RED front-line trace	1	1	.2	1	1	.2	.2	1	2.5
6. --- BLUE front-line trace	1	1	.2	1	1	.2	.25	1	2
7. --- area occupied by RED combat units	5.8	5.2	5.8	5.8	5.2	5	3	3	2
8. --- area occupied by BLUE combat units	5.8	5	5.8	5.8	5	5.5	3.2	5	3.5
9. --- area occupied by RED combat support units	2	5	5.8	3	5.2	5	1	3	2.5
10. --- area occupied by BLUE combat support units	2	5	5.8	3	5	4.5	1	5	1

[a]Responses from controllers positioned at the forward company controllers' console (N=3, except as noted).

[b]Responses from controllers positioned at the fire support console (N=3, except as noted).

[c]Responses from controllers positioned at the aggressor console (N=4 for "frequency of use" and importance and N=2 for "frequency reported", except as noted).

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
11. ---area occupied by RED combat service support units	1	1.2	5.8	1	1.2	4	.8	1	1
12. ---area occupied by BLUE combat service support units	1	1.2	5.8	1	1.2	4.5	.25	.8	1.5
13. ---command posts of RED combat units	.2	.2	1.2	.2	.2	1.5	0	.2	.5
14. ---command posts of BLUE combat units	1	.2	1.5	.8	.2	2.5	.25	.2	2.5
15. ---command posts of RED combat support units	.2	.2	1.8	.2	.2	1	0	.2	1
16. ---command posts of BLUE combat support units	.2	.2	.5	.2	.2	1	0	.2	1
17. ---command posts of RED combat service support units	.2	.2	.5	.2	.2	.5	0	.2	1[e]
18. ---command posts of BLUE combat service support units	.8	.2	1.2	.8	.2	.2	.2	.2	0
19. ---direction of movement of RED combat units	5	5.8	5.8	5	5.8	5	4.8	3	4
20. ---direction of movement of BLUE combat units	5.8	5.8	5.8	5.8	5.8	5	3	4	4

[e]Only one controller at the aggressor console responded to "frequency reported" for items 17-31.

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
21. ---direction of movement of RED combat support units	3	5.2	5.8	4	5.2	4.5	2.8	3	3
22. ---direction of movement of BLUE combat support units	3	5	5.8	4	5	4.5	2.8	3.8	0
23. ---direction of movement of RED combat service support units	.2	1.2	3.5	.2	1.2	4	0	1	0
24. ---direction of movement of BLUE combat service support units	.8	1.2	3.5	.8	1.2	3.5	.2	1.2	0
25. ---RED ground radar devices	.2	.2	.5	.2	.2	.2	0	.2	0
26. ---BLUE ground radar devices	3	2	.5	3	2	2	3	1	3
27. ---RED ground sensors	.2	.2	.2	.2	.2	.2	0	.2	0
28. ---BLUE ground sensors	1	.8	.2	4	.8	1.5	.8	1.2	3
29. ---RED observation posts	.5[d]	.2	1	.5[d]	.2	1	0[d]	.2	2
30. ---BLUE observation posts	.5[d]	.2	.2	.5[d]	.2	.2	0[d]	.2	0

[d] $_{N=2}$

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
31. ---RED night vision devices	.2	.2	0	.2	.2	.2	0	.2	0
32. ---BLUE night vision devices	2	.8	0	3	.8	.2	1	.2	0
33. ---RED airborne sensors	.2	1	.2	.2	1	.2	.2	1	0
34. ---BLUE airborne sensors	.2	1	1	.2	1	3.5	.2	1	3.5
35. ---coverage of RED ground radar devices	.2	.2	.2	.2	.2	.2	0	.2	0
36. ---coverage of BLUE ground radar devices	1.5	2	.5	1.2	2	2	1	1	2
37. ---coverage of RED ground sensors	.2	.2	.2	.2	.2	.2	0	.2	0
38. ---coverage of BLUE ground sensors	.2	.8	.2	2	.8	.5	.2	.8	.5
39. ---coverage of RED observation posts	0[f]	.2	.2	0[f]	.2	.2	0[f]	.2	0
40. ---coverage of BLUE observation posts	0[f]	.2	0	0[f]	.2	.2	0[f]	.2	0

[f] $N=2$

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
41. ---coverage of RED night vision devices	0	.2	.2	.2	.2	.2	0	.2	0
42. ---coverage of BLUE night vision devices	.5	.2	0	2	.2	.2	.5	.2	0
43. ---coverage of RED airborne sensors	0	1	.2	0	1	.2	0	.8	0
44. ---coverage of BLUE airborne sensors	0	1	1	0	1	3.5	0	1	3.5
45. ---RED antitank rockets	2	5	1	4.8	5.2	.5	1	2	0
46. ---BLUE antitank rockets	4	.2	.5	4.8	5	.5	2	.2	0
47. ---RED antitank missiles	2	5	.5	4.8	5.2	.5	1	2	0
48. ---BLUE antitank missiles	4	.2	.5	4.8	4.8	.5	2	.2	0
49. ---RED artillery weapons	1	5.8	1.5	4	5.8	3.5	1.8	5.8	3.5
50. ---BLUE artillery weapons	.2	5	.5	.2	5	2.5	.2	5	2.5

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
51. ---RED air defense weapons	0	5.8	.2	.2	5.8	.2	0	5.8	0
52. ---BLUE air defense weapons	1	.2	2	3.8	5	4	.8	.2	4
53. ---RED mortars	2	5.8	1.5	2	5.8	2.5	1	5.8	2.5
54. ---BLUE mortars	2.8	4	.2	2.8	4	.2	.2	4	0
55. ---RED air strikes	5	4	3.5	5	5	3	5	4.2	0
56. ---BLUE air strikes	1	4	4	4.5	5.8	4	4.5	4	1
57. ---RED preplanned targets	.2	0	.2	1	.2	.2	0	0	0
58. ---BLUE preplanned targets	1	1	0	3	1	.2	.8	1	0
59. ---RED impacting fires	5.8	6	5.5	5.8	6	4.5	5	6	1.5
60. ---BLUE impacting fires	5.8	6	5.5	5.8	6	4.5	5	6	1.5

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
61. ---RED platoon control measures	2[g]	0	3	5[g]	.2	3	0[g]	0	0
62. ---BLUE platoon control measures	4.5	.2	.2	4.5	1	3	4	.2	0
63. ---RED company team control measures	2	.2	3	5	3	3	0	.2	0
64. ---BLUE company team control measures	5	4	3	5	4	3.5	4	4	3.5
65. ---RED battalion task force control measures	2	.2	3	5	3	3	0	.2	0
66. ---BLUE battalion task force control measures	5	4	3	5	4	5.5	3.5	4	3.5
67. ---RED brigade control measures	2	.2	3	5	.2	3	0	.2	0
68. ---BLUE brigade control measures	5	.2	2.5	5	.2	5.5	3.5	.2	2.5
69. ---RED division control measures	2	.2	3	5	.2	3	0	.2	0
70. ---BLUE division control measures	5	2	1.5	5	2	4.5	3.5	2	1.5

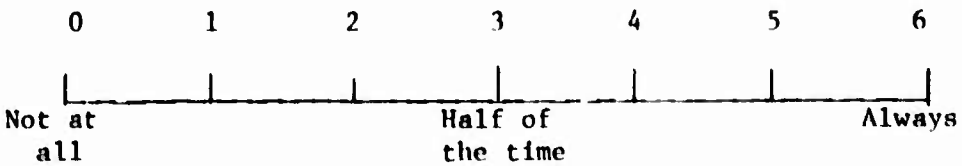
[g]For all remaining items, only two controllers at the forward company controllers' responded except for items 71, 72, and 73. For items 71 and 72, only one responded. For item 73, three responded.

Information Item	Freq. Use			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
71. ---RED terrain information	6	2	3[h]	6	2	3[h]	6	2	0
72. ---BLUE terrain information	6	5	3[h]	6	5	3[h]	6	3	2.5
73. ---game time	3	5.8	5.8	2	5.8	5.8	.2	5.8	2.5

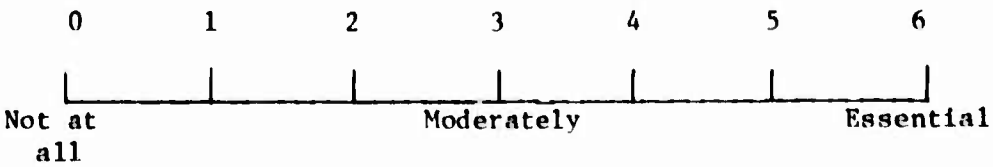
[h] $_{N=3}$

2. On the following pages are listed alert messages that could have been received at your console during training exercises. Read each alert to determine if it were received at your console. If it were, then consider the ways in which you used it during a "typical" training exercise in the period of system definition research.
Next answer the following questions about each alert by selecting the appropriate numbers on the scales below the questions:

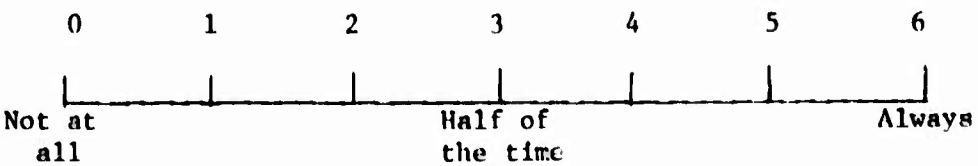
a. Compared to the frequency with which the alert was displayed during an exercise, how often did you make use of the information provided by it?



b. How important was the information in this alert to you in your role as a controller?



c. Compared to the frequency that the alert was displayed during an exercise, how often was information contained in it reflected in your communications to a player?



In responding to an alert, first indicate whether the alert was displayed at your console. That is, place a check in the first space to the left of the alert if it appeared at your console. Then place the numbers representing your responses to the three questions in the appropriate spaces.

Select your responses in terms of the typical training exercise. Answer the questions in terms of your principal military role during an exercise if you were a blue controller. Answer the questions in terms of the mixture of roles that you played if you were a red controller.

Alert	Freq			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
1. ---violation of control measure	2.8	2[d]	1.5[d]	2.8	2	2[f]	.8	.2	0
2. ---crossing control measure	3.2	.2	3[e]	3	.2	3	2.8	.2	3
3. ---air strike casualties	4.5	5.8	5.8	4.5	5.8	5.8[g]	3.8	5	6
4. ---arrival at obstacle	5	3	4.5	5	3	5.8	4	1	6
5. ---weather	4	.2	5.8	4	.2	6	1.8	.2	0
6. ---road damage	.2	.2	3	.2	.2	5.8	.2	.2	3
7. --bridge damage	.2	.2	3	.2	.2	5.8	.2	.2	0

[a]Responses from controllers at the forward company controllers' console (N=3, except as noted).

[b]Responses from controllers at the fire support console (N=3, except as noted).

[c]Responses from controllers at the aggressor console (N=4 for "frequency use", 3 for "importance", and 1 for "frequency reported", except as noted).

[d]N=2

[e]N=3

[f]N=2

[g]N=4

Alert	Freq.			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
8. ---REDCON status	2.2	.2	3	3	.2	6	2	.2	6
9. ---minefield encounter	5	5.8	6[e]	5	5	6	4	5	6
10. ---air unit hit by ground unit	.5	.2	6[e]	.5	.2	6	.5	.2	6
11. ---ground unit's engaging air unit	2	2	5.8	4	4	6	4	2	6
12. ---air unit's receiving fire from ground unit	0	.2	5.8	0	.2	6	0	.2	6
13. ---cease fire at air unit	.2	4	3	.2	3	5.8	.2	1	0
14. ---change in status of air unit	0	.2	3	0	.2	5.8	0	.2	0
15. ---visual detection	4	5.8	1.5	5	5.8	5.8	3.8	5	0
16. ---radar detection	3	0	3	4	0	5.8	3	0	3
17. ---unattended ground sensor alarm	2	0	3	3	0	6	1	0	6

Alert	Freq.			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
8. ---change in rate of travel	4	5	4	5	5	5.5[g]	3	2	3[h]
9. ---air unit's detecting ground unit	0	4	5.5	0	4	5.8	0	3.8	5
10. ---ordnance delivery	.2	3	5.8	.2	3	6	.2	3	6
21. ---artillery delivery	.2	6	4.5	.2	6	4.5[g]	.2	5.8	.5[h]
22. ---report receiving fire (engagement)	4.2	5.8	5.8	5	5.8	6	4.8	4	6
23. ---report of contact (engagement)	4.2	5.8	5.8,	5	5.8	5.8[g]	4	4	3.5[h]
24. ---casualty report	4.2	5	5.8	5	4	5.8	4	4	3
25. ---ammo request	3	5.8	3	5	5.8	5.8	1	2	0
26. ---fuel request	3	2	3	5	2	5.8	1	1.8	0
27. ---CP HQ destroyed	1	.2	5.8	4	.2	6	.2	.2	0

[h] $N=2$

Alert	Freq.			Importance			Freq. Reported		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
28. ---CP HQ commo restored	.2	.2	5.8	2	.2	6	.2	.2	6
29. ---resupply from	3	5	3	3	4	5.8	1	2	0
30. ---resupply to	3	5	3	3	4	5.8	1	2	0

3. Below are listed the types of information that could be obtained from a special status report (that is, the status reports that could be called up on the A/N CRT):

game time	status of personnel
location of unit	status equipment
movement rate	status of ammunition
elevation of unit	status of fuel

Consider the times that you called up special status reports for blue units. From the types of information just presented, develop and list the categories of information that you were seeking in calling up special status reports for blue units. Each category should indicate the types of information that you were seeking on at least one occasion during a training exercise. All categories together should describe the various groupings of information that you sought during training for blue units. A category may contain as many types of information as required. Each type of information may be used more than once.

For example, it may be that during training, you sought only two types of information about blue units from special status reports, information about the status of personnel and/or equipment. That is, you sought information about either personnel or equipment on some occasions, but you sought information about both on other occasions. In this example then, three categories of information would be listed:

personnel
equipment
personnel and equipment

After developing and listing the categories, estimate the proportion of times that you called up special status reports for blue units for each category of information. Your estimates should total 100 per cent. Place your estimate for a category beside it in the list that you develop below.

Category of Information	Median Proportions [a] Estimated by Consoles		
	1[b]	2[c]	3[d]
Location of Unit (LU)	.03(1)	.20(1)	.00(0)
Movement Rate (MR)	.04(3)	.10(1)	.35(1)
Elevation of Unit (EU)	.01(1)	.10(1)	.00(0)
Status of Personnel (SP)	.06(3)	.10(1)	.10(2)
Status of Equipment (SE)	.08(3)	.15(3)	.10(2)
Status of Ammunition (SA)	.05(3)	.60(1)	.00(0)
Status of Fuel (SF)	.04(3)	.10(1)	.05(2)
LU/ Game Time (GT)	.00(0)	.00(0)	.25(0)
LU/MR	.05(1)	.10(0)	.00(0)
SP/SE	.40(2)	.75(1)	.30(1)
SA/SF	.05(2)	.00(0)	.00(0)
GT/LU/MR	.00(0)	.00(0)	.25(1)
MR/SP/SE	.40(1)	.00(0)	.00(0)
SP/SE/SF	.00(0)	.00(0)	.10(0)
Others	.04(2)	.00(0)	.00(0)
No Reason	.01(1)	.00(0)	.00(0)

[a]The proportion for a category represents the median proportion estimated by the respondents who formed the category and who were located at a particular console. The figure in parentheses represents the number of respondents.

[b]Responses from controllers at the forward company controllers' console.

[c]Responses from controllers at the fire support console.

[d]Responses from controllers at the aggressor console.

4. Below are listed the types of information that could be obtained from a special status report (that is, the status reports that could be called up on the A/N CRT):

game time	status of personnel
location of unit	status equipment
movement rate	status of ammunition
elevation of unit	status of fuel

Consider the times that you called up special status reports for red units. From the types of information just presented, develop and list the categories of information that you were seeking in calling up special status reports for red units. Each category should indicate the types of information that you were seeking on at least one occasion during a training exercise. All categories together should describe the various groupings of information that you sought during training for red units. A category may contain as many types of information as required. Each type of information may be used more than once.

For example, it may be that during training, you sought only two types of information about red units from special status reports, information about the status of personnel and/or equipment. That is, you sought information about either personnel or equipment on some occasions, but you sought information about both on other occasions. In this example then, three categories of information would be listed:

personnel
equipment
personnel and equipment

After developing and listing the categories, estimate the proportion of times that you called up special status reports for red units for each category of information. Your estimates should total 100 per cent. Place your estimate for a category beside it in the list that you develop below.

Category of Information	Median Proportions [a] Estimated by Consoles		
	1[b]	2[c]	3[d]
Location of Unit (LU)	.03(1)	.20(1)	.00(0)
Movement Rate (MR)	.10(3)	.30(1)	.52(2)
Elevation of Unit (EU)	.10(1)	.00(0)	.00(0)
Status of Personnel (SP)	.22(2)	.15(2)	.15(3)
Status of Equipment (SE)	.22(2)	.15(2)	.15(3)
Status of Ammunition (SA)	.12(2)	.10(1)	.00(0)
Status of Fuel (SF)	.00(0)	.10(1)	.05(2)
LU/MR	.15(1)	.00(0)	.00(0)
SP/SE	.58(2)	.60(1)	.52(2)
Other	.06(2)	.00(0)	.00(0)

[a]The proportion for a category represents the median proportion estimated by the respondents who formed the category and who were located at a particular console. The figure in parentheses is the number of respondents.

[b]Responses from controllers at the forward company controllers' console.

[c]Responses from controllers at the fire support console.

[d]Responses from controllers at the aggressor console.

5. Below are listed six sources from which you could have obtained information during a training exercise. Consider the "typical" training exercise during system definition research. For the typical exercise, rank the sources in terms of the frequency with which you obtained information from them about the tactical situation. Use the numbers one to indicate the most frequently consulted source. The number six should be used to designate the least frequently consulted source.

Output Source	Median Ranking by Console		
	1[a]	2[b]	3[c]
alerts	2.0	2.2	2.0
15-minute summaries	6.0	6.0	6.0
graphic information	1.2	1.2	1.5
other controller	3.0	3.2	3.5
RATT message	5.2	5.0	4.5
special status report	2.0	2.0	4.0

[a]Responses from controllers at the forward company controllers' console (N=3).

[b]Responses from controllers at the fire support console (N=3).

[c]Responses from controllers at the aggressor console (N=4).

6. Was there any type of information that you needed as a controller and that could not be obtained from the computer? Yes 5 No 5

If yes, what were they? (N=5)

---In addition to the initial engagement alerts, information regarding which weapons are firing at which target (1B, 1R, 1A).
---Information regarding line of sight between units at a given moment (1B, 1A).
---Information about the effects of specific weapons, i.e., "what weapons killed me and which weapons killed him" (1B).
---Percentage that a unit was suppressed at a given moment (1A).
---Whether command and control inputs can be made for a unit and, if not, the corresponding reason (1B).
---Visual graphics with improved capabilities for acquiring information about terrain (1B).
---Shell reports: location of impact, direction of hostile weapon, and type of hostile weapon (1B).

7. Were there types of information requested by players that were not provided by the computer outputs? Yes 4 No 7

If yes, what were they? (N=4)

---SLAR information (1R).
---Infrared information (1R).
---Whether an enemy unit was dug in (1A).
---Weapons that caused losses (1B).
---Why units were "stopped" (1B).
---Shell reports (1B).

8. Did any of the following sources provide information that you did not need to conduct training: graphic CRT, A/N CRT, or special status report? Yes 4 No 6

If yes, list this information for each source. (N=6)

---Special status reports are not essential for brigade controller (1R).
---Elevation in special status reports (1B).
---RATT messages (1B).
---Aural detection alerts (1B).
---Graphic information about the coverage of observation posts, RED night vision devices, and airborne sensors (1B).
---Level of detail of some outputs (e.g., 8-digit coordinates) was greater than necessary (1B).

9. Did you ever use a 15-minute summary during an exercise in order to control the exercise? Yes 1 No 10

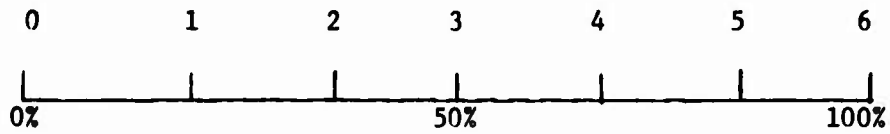
If yes, during how many of the training exercises for the last five groups did you consult a 15-minute summary for training purpose?

2 (place number)

Indicate why the 15-minute summary was not used (or used more often)? (N=7)

---Time constraints did not permit their use (2B, 1R, 1A).
---Time required to analyze them (1B, 1A).
---Difficult to read (1B).
---Difficult to understand (1B).
---Information not needed (3B).
---Information was untimely, that is, after-the-fact (1B, 1A).

10. Place an X over the appropriate number on the scale below to answer the following question: how well were you able to predict events modelled by the computer on the basis of computer outputs?



Console	Median Response[a]
Forward Company	4.5 (3)
Fire Support	5.0 (2)
Aggressor	4.8 (3)

[a]Numbers in parentheses are the frequency of controllers at the console that responded.

Describe areas which you believe that you should have been able to have predicted more accurately than you were able to. (N=3)

---Movement rates (1R).
---Weapon effects (1R).
---Ability to determine from terrain the line of sight between elements (1B).

11. Some types of problems and events on the actual battlefield come to a commander's attention through a steady build-up of information. Were there events or problems about which the computer did not provide you the realistic build-up of information that you might have expected?

Yes 3 No 8

If yes, describe the events or problems for which the build-up could be improved. (N=2)

---Radars could have detected enemy movement and artillery weapons (1B).
---Controllers create realistic build-up by using outputs or cues from the computer (1B, 1A).

12. Did you experience difficulty in maintaining the exact status of a unit during an exercise? Yes 3 No 8

If yes, describe the nature of the difficulty, and describe changes in the HW/SW or operational procedures that would reduce the difficulty. (N=5)

---Observer area needs an A/N CRT to furnish alerts, special status reports, etc. (1A).
---Determining when an artillery unit is out of ammunition (1B).

13. What questions about the tactical situation were you attempting to answer by calling up special status reports for units of the opposing force? List. (N=9).

---Battle damage assessment (1B).
---Rate of movement (1B, 1R).
---Status of personnel (4B, 3R, 2A).
---Status of equipment (3B, 3R, 1A).
---Ammunition status (1B).
---Reasons for not moving (1B).
---Effects of tactical formations (1B).

Would alerts or graphic information have provided the answers? Yes 2 No 5

14. Were there occasions in which a player requested information and in which you were delayed in obtaining the requested information from computer outputs? Yes 4 No 6

If yes, what circumstances associated with the tactical exercise, HW/SW, or operating procedures caused the delays. (N=4)

---The "normal problems" of command and control in combat (1B).
---System failures (1B).
---Hardware availability (2B).
---Need to access computer for special status report and then add figures in it to provide a requested ammunition count (1B).

15. Compare the information that you provided to players at your own instigation with the information provided to players at their request.

Was there any difference in terms of quality? Yes 2 No 8

If yes, describe the differences. (N=2)

---Information provided at own instigation was "better" or more "thought out". (1B, 1A).

Were both types of information (communications) based on computer outputs to the same degree? Yes 7 No 3

If no, why? (3)

---Compared to unsollicited information, requested information was not embellished by personal experiences of the controller. Consequently, it was more "official" and conveyed loss of such "human elements" as panic and pressure (2B).

16. This set of requirements applies only to those controllers who, in their military roles, communicated to players.

Instructions. --- Below are described ways in which, according to our observations, computer outputs were transformed or modified in communicating them to players. Reasons that could have caused a controller to transform the outputs are also described.

After reading the transformations and the possible reasons, you are given two requirements. First, you are to rank order the modifications in terms of the frequency with which you recall having made them in your principal military role during a "typical" training exercise. Use the number one to designate the most frequent transformation and the number three to designate the least frequent. Place the numbers in the spaces provided beside the transformations. Second, indicate the reasons, from the ones described, that caused you to make the transformations. As many reasons as necessary may be indicated. For each reason indicated, cite examples of outputs that were modified because of it.

Transformations. --- Three types of modifications were observed:

Added information --- the communication contained a greater amount of information (or more detailed information) than was contained in relevant computer outputs.

Reduced information --- the communication contained a lesser amount of information (or less detailed information) than was contained in relevant computer outputs.

Different information --- the communication was inaccurate in comparison to available computer outputs.

Reasons for Transformations. --- A transformation could have been made for one or more of the following reasons:

Role realism --- to reflect the tone of the tactical situation; to provide a more real-world problem; to convey the appropriate information given the tactical situation.
MM incorrect --- known errors in the math model.
MM incomplete --- information not fully taken into account by the math model or reported in computer outputs in an incomplete or unclear fashion.
MM inaccessible --- unable to receive relevant outputs in a timely manner because of competing role demands or operational characteristics of the output mechanisms.

(Item 16 cont'd on following page)

(Item 16 cont'd from preceding page)

Information in MM conflicts --- computer outputs provided in the same time period were not consistent.
MM malfunction --- computer down, no current outputs available.
Controller error --- communication of inaccurate information under conditions other than those specified for the other reasons.

First Requirement. --- Rank order the modifications in terms of their frequency of occurrence (1-most frequent; 3-least frequent).

Transformation Type	Model Response at Console			
	1[a]	2[b]	3[c]	4[d]
Reduced Information	1	1	1	1
Added Information	2	2.5	2	2
Different Information	3	2.5	3	3

[a]Forward company controllers' console (N=3).
[b]Fire support console (N=2).
[c]Aggressor (higher/adjacent roles) console (N=2).
[d]All respondents together.

Second Requirement. --- Identify the reasons that prompted you to add information. Cite examples. (N=8)

--- Role realism: type of fire, enemy activity, problems with subordinates (3B, 3A).
--- Math model incorrect: suppression effects (1B).
--- Math model incomplete: smoke, types of ammunition, activities of adjacent units (2B, 1R).
--- Math model malfunction (1B, 1R).

(Item 16 cont'd on following page)

(Item 16 cont'd from preceding page)

Identify the reasons that prompted you to communicate different information. Cite examples. (N=6)

--- Role realism (2B, 1A).
--- Math model incorrect: weapon effects, suppression effects, visual detections (3B).
--- Math model incomplete: smoke, types of ammunition, minefield breaking activities (3B).
--- Math model malfunction (1R).

Identify the reasons that prompted you to communicate reduce information. Cite examples. (N=8)

--- All reasons cited related to "role realism". Five respondents (2B, 2R, 1A) indicated that information about the entire battle was available and that to communicate this would be unrealistic. Three respondents (3B) indicated that computer-generated information was too complete to relay to players.

17. Consider the ease with which you were able to get access to --- that is, to identify or receive --- computer outputs from each of the following output sources: graphics, alerts, and special status reports. For each output source, describe all difficulties that you experienced in getting access to information. Indicate if a difficulty was associated with a particular type of information.

graphics: (N=11)

--- None (2B, 4R, 1A).
--- Competing information needs of another controller (2B).
--- Distracted by need to communicate with players (1B).
--- Need to adjust camera so that it covered the relevant unit (1B).
--- Due to the quality of the map, information about the terrain could not be obtained easily (1B).

alerts: (N=11)

--- None (1B, 3R).
--- Information from alert messages was not always available when needed (1A).
--- Clearing alerts from the A/N CRT (1B, 1R, 1A).
--- Did not receive all the information needed through alerts about red units (1B).
--- Need to consult aggressor console for casualty reports (1B).
--- Competition for use of A/N CRT among controllers at console (1B).

special status reports: (N=11)

--- None (2R, 1A).
--- Difficult format. After learning the format, there was no problem (1B).
--- Additional information would be desirable: amount suppressed, the commands that the unit is following, activities of the unit (1B).
--- Calling up special status reports: time consuming and possibility of making errors (1B, 1R).
--- Time consuming to print special status reports (1B).
--- Multiple functions of A/C CRT. RATT messages pre-empt special status reports. Time was lost in calling up a series of reports because alert messages were reprinted and then had to be cleared between each report (1B).

18. Now consider your uses of information from graphics, alerts, and special status reports after you had obtained access to it. Describe any difficulty in using the information from each source due to the manner in which it was displayed. (N=11)

graphics:

--- None (5B, 3R, 1A).
--- Graphics were too cluttered. Some types of graphical information were not displayed because they cluttered the graphics CTR (1R).

alerts:

--- None (1B, 2R).
--- Reports of losses did not provide the current unit strength. As a result, keeping track of unit strength was difficult (1B).
--- Difficult to read (1B).
--- Provided more detail than was needed to communicate (1R).
--- Dropping alerts from the A/N CRT (1B).

special status reports:

--- None (2B, 3R).
--- Too much information provided (1A).
--- It was necessary to translate specific information into more general information (1B).

19. What changes, if any, would you recommend in order to improve the use of information provided through each of the following: (N=11)

graphics:

--- None (2B, 4R).
--- A graphic CRT for each controller (2B).
--- Information about line of sight between units (1B, 1A).
--- Better maps (1B).

alerts:

--- None (1B, 4R).
--- Their presentation needs to be changed so that they are easier to read and understand (1B, 1A).
--- Change the schedule according to which they are displayed (1A).
--- A separate A/N CRT for each controller (1B).
--- Shell reports (1B).
--- Reports on unit's running out of ammunition (1B).

special status reports:

--- None (3B, 3R).
--- Simplify the method for requesting special status reports (1R).
--- A separate A/N CRT for each controller (1B).

20. a. Indicate whether you ever experienced any of the following difficulties during a training exercise:

Yes			No			
1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	
2	2	1	1	1	3	(1) There was a delay in locating needed information on the graphic CRT because the map scale was too large.
2	3	1	1	0	3	(2) There was a delay in locating needed information on the graphic CRT because the map scale was too small.
3	3	4	0	0	0	(3) There was a delay in locating needed information on the graphic CRT until the portion of the map being displayed could be changed.
3	2	4	0	0	0	(4) There was a delay in locating needed graphic information because the center controller was involved in other duties.
3	1	4	0	2	0	(5) The display of needed graphic information was blocked by command and control menu options.
0	0	1	3	3	3	(6) The images of graphics were unclear when a command and control input was being made.
0	1	0	3	2	4	(7) Due to my position at the controller console, reading graphic information was difficult.
0	1	3	3	2	1	(8) Due to the amount of information on the graphic CRT, it was difficult identifying needed information.
0	2	3	3	1	1	(9) An important alert message was delayed because a special status report was being displayed on the A/N CRT.

(Item 20 cont'd on following page)

(Item 20 cont'd from preceding page)

Yes			No				
1[a]	2[b]	3[c]	1[a]	2[b]	3[c]		
1	0	0	2	3	4	(10)	The formatting of alerts made them difficult to read.
2	2	2	1	1	2	(11)	There was a delay in calling up a special status report because the A/N CRT was being used for another function.
2	1	2	1	2	2	(12)	A special status report was delayed because the operator of the A/N CRT had other duties to attend to.
0	0	0	3	3	4	(13)	The format of special status reports created difficulty in identifying needed information.
0	0	0	3	3	4	(14)	Information from one output source was not compatible with information from another source.

[a]Frequency of responses from controllers at the forward company controllers' console.

[b]Frequency of responses from controllers at the fire support console.

[c]Frequency of responses from controllers at the aggressor console.

(Item 20 cont'd on following page)

(Item 20 cont'd from preceding page)

20. b. Because of its frequency or the conditions under which it occurred, do you consider any of the above difficulties to be a significant problem? If so, indicate which ones are significant problems by listing the appropriate numbers.

Item Number	Number of Controllers Endorsing
# 3	2
# 4	6
# 5	2
# 7	1
# 8	2
# 10	1
# 12	1
# 13	1

21. Would you prefer to receive alerts <u>automatically</u> as you currently do or <u>on call</u> as you do for special status reports? (N=11)

All respondents preferred to receive alerts <u>automatically</u>.

22. Did you ever fail to receive an alert which you had expected? Yes <u>3</u> No <u>8</u> Why do you think that this occurred? (N=3)

--- Pre-occupied by something else (A).
--- Computer down (B).
--- The alert was cleared from the A/N CRT before it could be read (R).

23. Was there a need for additional output devices, for example, an A/N CRT used exclusively for special status reports? Yes 8
No 4

If so, describe the needed devices. (N=9)

--- A CRT for each controller (3B, 2R).
--- A graphic CRT for each controller (1B).
--- A graphic CRT the accessability of which is not reduced by command and control menus (1B).
--- An additional A/N CRT at each console (1A).
--- An A/N CRT at the observer station (1A).

24. List and describe inaccuracies in the math model that you took into account in controlling training exercises. For each inaccuracy, indicate what you did to insure that it did not degrade the realism and/or effectiveness of an exercise. (N=9)

Inaccuracy	Response
(1) Weapon effects (2B, 1A)	---adjusted effects based on personal experience. ---used control measures to hide and maneuver units.
(2) Smoke not modelled (1B, 1A).	---changed weather conditions to create smoke-like effects.
(3) ICM not modelled (1B).	---none.
(4) Visual detection rates too high (1B).	---manually reduced it by considering time, terrain, etc.
(5) Suppression effects/ excessive firing rates (1B, 1A).	---presented fabricated information to players. ---increased strength of a unit to avoid suppression.
(6) Terrain (obstacle effects) (1B, 1R, 1A)	---avoided impossible terrain. ---presented fabricated information to players. ---imposed time delay for obstacles.
(7) SLAR/Infrared (1R).	---none.
(8) No engineer model (1A).	---played by best guess.
(9) Decimated units modelled as intact fighting unit. Remnants of unit could hold up larger unit (1A).	---deactivated recalcitrant remnants.
(10) Movement rates excessive (1A).	---arbitrarily slowed movement.
(11) Ammunition expenditure rates excessive (1A).	---resupplied units as deemed appropriate.

25. Identify computer outputs that consistently lacked credibility. In identifying the outputs, indicate both the content (meaning or subject) of the output and the output source (graphics, alerts, special status reports, 15-minute summary, etc.). (N=8)

(Note: This question elicited meaningful answers regarding the content of incredible outputs. Only content is listed below).

--- Reports of violation of NFL, FSCL (1B).
--- Weapon effects (3B, 1R).
--- Movement rates (2R).
--- BDA (1R).
--- Fuel consumption (1R).

26. Do you believe that any of the math model inaccuracies was noticeable to the players? Yes 7 No 5

If yes, which ones? (N=8)

--- Smoke and other types of artillery ammunition (2B, 1R).
--- Air module (1B, 1A).
--- BDA (2R).
--- Fuel consumption rates (2R).
--- Weapon effects (1R).
--- Suppression (1B).
--- Terrain effects (1B).
--- Obstacles (1R).
--- Play of elements not modelled (1A).

27. What, if any, types of information did you communicate to players that were not provided by computer outputs? (N=9)

--- Information (excitement, pressure, fatigue) calculated to promote realism (3B).
--- Smoke and other types of artillery ammunition (2B).
--- Information about adjacent elements (1R, 1A).
--- Brigade analysis of situation (1A).
--- Air-delivered unattended ground sensor alerts (1R).
--- SLAR/infrared reports (1R).

28. Do you believe that you understand the math model to such an extent that during an exercise, you were able to anticipate what was likely to occur in the tactical operations modelled by it? Yes 7 No 4

29. During training exercises, command and control inputs were initiated for different purposes.
Some inputs, for example, were initiated for administrative purposes, such as to reduce the clutter on the graphic CRT by de-activating units. Other inputs were made to execute a tactical action, such as issue a fire command. In the table below, first identify and list the purposes for which you initiated command and control inputs. Then list by menu labels (e.g., fire control; activate units) the command and control used for each purpose. Finally, estimate and list the proportion of all command and control inputs initiated by you for each purpose. An example is provided.

Purpose	Command & Control Inputs	Proportion
Example	Example	Example
Administrative	Unit location activate units resupply	10%

Table C-1

Proportions (Median) of Command and Control

Inputs Estimated by Controllers at Each Console

Command & Control Input	Console		
	Forward Company[b]	Fire Support[c]	Aggressor[d]
Maneuver Control	.50	.10	.50
Fire[a] Control	.35	.82	.25
Other	.25	.08	.20

[a]Includes air strike, air defense, as well as fire control.

[b]N=3

[c]N=2

[d]N=3

Table C-2

Responses of Controller Operating Command & Control

Input Devices: Forward Company Console

Purpose	Command & Control Inputs	Proportion
Administrative	Unit location, activate units, Resupply	.10
Task Organization	Task Organization	.05
Move	Maneuver Control	.30
Fire	Fire Control	.35
Establish Control Measures	Control Measures	.05
Change Unit Size		.05
Resupply		.10

Table C-3

Responses of Controller Operating Command & Control Input Devices: Fire Support Console

Purpose	Command & Control Inputs	Proportion
Tactical	Fire Control	.40
	Maneuver Control	.10
	Air Strike	.30
	Control Measure	.05
	Preplanned Mission	.05
	Air Defense	.05
Administrative	Weather	.05

Table C-4

Responses of Controller Operating Command & Control

Input Devices: Aggressor Console

Purpose	Command & Control Input	Proportion
Administrative	Unit location, activate units, resupply	.05
Execute Tactical Action	Air Strike Preplanned Mission Fire Control Maneuver Control	.05 .05 .25 .50
Control Measure	Control Measures	.10

30. (For blue controllers only) Consider the tactical actions that you took in your principal military role during the "typical" training exercises by initiating command and control inputs.

What proportion was based on decisions/commands/orders communicated to you by a player?

N=7
range = .10 - .80
median = .40

What proportion was initiated by you in your military role?

N=7
range = .20 - .90
median = .60

31. Were there decisions reflected in players' tactical operation orders that would have ideally been incorporated in the initial conditions of the math model but that could not be? Yes 4 No 6

If yes, what were they? (N=4)

--- Engineer activity (1B).
--- Positioning of unattended ground sensors (1A).
--- Smoke (1B).
--- Standard aircraft loads (1B).
--- Emplacement of individual weapons at specific locations (1A).

32. Were there command and control inputs which the math model failed to enact as you had intended or expected? Yes 6 No 3

If yes, identify the command and control inputs and the conditions associated with this occurrence. (N=5)

Command & Control Input	Conditions
Artillery Fire Control (1B, 1R)	--- frequent "no-fire". --- no fire because unit was out of ammunition without controller's knowing this.
Maneuver Control (3B, 1R)	--- unit not moving because it was suppressed. --- movement codes of "exploitation/ pursuit" and "movement to contact" had same effects. --- the operation states of "force defense"and "position defense" did not have expected effects.

33. Were there effects of any command and control input that lacked credibility? Yes 4 No 6

If yes, describe them. (N=4)

--- weapon effects (3B).
--- air module (1B).
--- movement rates unaffected by terrain (1R).

34. Would your capability to control the tactical situation have been improved if you had received certain computer outputs earlier than you did? Yes 1 No 10

If yes, describe both the relevant computer outputs and how your control would have been improved.

No responsive answers provided.

35. Were you able to plan and implement command and control inputs so that you could affect the math model in the desired time framework? Yes 10 No 1

If no, did this occur because of the math model or because of the timing of your initiation of the command and control inputs themselves? (N=1)

--- Timing of the initiation of inputs. Timing problems stemmed from an overloaded center controller (1B).

36. Discuss the extent to which you believe that you were actually tactically controlling units modelled by the computer? (N=9)

Eight controllers who controlled units responded. Estimates of extent of control ranged from "could not realistically control" to "total control". Most respondents (N=5) indicated that they felt as if they had much tactical control over their units. Suppression effects (2B) and fire control (1B, 1R) were cited as problem areas.

37. What difficulties, if any, did you experience in following a player group's concept of the operation? Describe the difficulties and their causes. (N=7)

None described.

38. Were there tactical actions that you would have liked to implement through command and control inputs but that you were unable to? Yes 2 No 9

If yes, list them. (N=2)

The following were listed by one or both of two blue controllers:

--- Fire commands for a greater variety of ammunition types.
--- Smoke.
--- Illumination.
--- Ambush.
--- Minefield emplacement and breaching.
--- Sensor emplacement.
--- Engineer preparation of defensive positions.

39. Describe any type of tactical decision/command/order issued by players that you could not implement by initiating one or more command and control input. (N=6)

--- None (1B, 1R).
--- Firing types of ammunition (smoke) that were not modelled (2B).
--- Creating man-made obstacles (1R).
--- Air-delivered mines (1B, 1R).
--- Airmobile instructions (1B).
--- Shooting down aircraft (1B).
--- Ambushes (1B).

40. For any command and control input, did the math model fail to provide readily accessible information confirming that the input had been received by and taken into account by the model? Yes 1 No 6

If yes, identify the inputs and/or conditions under which this occurred. (N=1)

This information was not readily accessible for any command and control input under any condition (1B).

41. For decisions/actions implemented through command and control inputs, did the model provide you with information that you needed about their effects on the tactical operation? Yes 9 No 1

If this information was not completely satisfactory to you, indicate the types of information you needed. (N=1)

There was a need for red damage assessments (1B).

42. Consider the decisions/commands/orders communicated to you by players.

For what proportion did you provide the players feedback about their implementation? (N=8)

Console	Median Estimate
Forward Company (N=3)	.65
Fire Support (N=3)	.50
Aggressor (N=2)	1.00
Total (N=8)	.73

43. Consider the times that you provided players feedback about the implementation of their decisions/commands/orders. Estimate the proportion of times that the feedback was best described by each of the statements below. Place your estimates in the spaces to the left of the statements.

Console

1[a]	2[b]	3[c]	
.40	.10	.50	the feedback was completely based on outputs of the computer
.50	.50	.45	the feedback was based on outputs of the computer and ad lib (planned or impromptu) information.
.10	.40	.05	the feedback was completely ad lib.

[a]Median response of controllers at forward company console (N=3).

[b]Median response of controllers at fire support console (N=2).

[c]Median response of controllers at aggressor console (N=2).

Describe the reasons for providing ad lib information to players. (N=6)

--- Weapons effects not modelled (2B).
--- Different types of ammunition not modelled (2B).
--- System failures (2B).
--- To make play more realistic (2B, 1R).

44. Were there any problems in making command and control inputs that were unique to the different training exercises conducted during system definition research? Yes 2 No 8

If yes, describe them. (N=2)

--- Weapons/smoke effects (1B)
--- "Realism" was greater in the ATTACK when units were modelled at platoon (as opposed to company) level (1R).

45. Describe changes in the math model or HW/SW devices that would improve the accuracy, completeness, and/or timeliness with which the math model accepts and takes into account the decisions of players and controllers. (N=5)

--- Modelling of smoke (1B).
--- Modelling of ICM, VT fuze (1B).
--- Modelling of air-delivered mines (1B).
--- Updated weapon effects curves (1B).
--- Altered air menu so that multiple passes and targets can be imputted and so that altitude and speed are automatically determined (1R).
--- Increased number of alert messages (1R).

46. Did you experience difficulties in identifying which command and control inputs would implement decisions/orders/commands issued by players? Yes 0 No 9

If yes, describe them. (N=0)

No responses.

47. After having identified command and control inputs to implement players' decisions/commands/orders, did you experience difficulties in selecting the menu options? Yes 0 No 8

If yes, describe the difficulties and the reasons for them. (N=0)

No responses.

48. It appeared as if the math model frequently rejected "fire control" command and control inputs because targets were out of the ranges of weapons. Did this occur because you were unable to always judge the ranges of the targets accurately? Yes 2 No 5

If yes, what HW/SW or procedural changes would assist you in more accurately judging a target's range? (N=8)

Comments regarding HW/SW:

---Model longer-range weapons (1B).
---Information as to whether a target can be fired upon (1B, 1R).
---Whether a target could be acquired by a weapon was determined by the range between the center of mass of a target and the center of mass of the weapon. The leading edges of targets were often within range whereas the centers of mass were not.

Comments Regarding Procedures:

---The most frequent reason for this occurrence was that all weapons were selected to fire to expedite fire control when all weapons were not in range (1B, 1R).
---This often occurred when fire control inputs were used to identify which weapons were firing (1B).

49. Check yes or no to indicate whether any of the following occurred in making command and control inputs. Check yes only if, in your opinion, an item was such a problem that it deserves consideration in planning future versions or uses of CATTS.

Yes			No			
Console			Console			
1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	
0	0	0	3	3	3	error made in making an input due to the scale (zoom setting) of the map.
0	0	0	3	3	3	accidental activation of the analog graf pen over the wrong input option.
2	1	2	1	2	1	need to adjust the scale or portion of the map viewed while making an input.
0	0	0	3	3	3	failure to recall code words used in command and control menus.
0	0	0	3	3	3	lack of coordination between the controller initiating the input and the controller operating the command and control input mechanisms.
0	2	0	3	1	3	untimely delay in placing a command and control input in the model due to a backlog of inputs.
0	1	0	2	2	3	need for command and control input operator to supply information for inputs initiated by another controller.

[a]Frequency of responses from controllers at forward company console.

[b]Frequency of responses from controllers at fire support console.

[c]Frequency of responses from controllers at aggressor console.

50. Did you ever initiate command and control inputs for units or events for which you were not responsible in one of your military roles? Yes 5 No 5

If yes, why? (N=4)

--- Operator of command and control input mechanisms was preoccupied (2B, 1R).
--- If orders of players to another controller were straight forward, the operator would execute them without waiting for instructions from the other controller (1B).

51. Did the requirement for the center controller to make command and control inputs for the other two controllers have any of the following effects:

Yes			No			
Console			Console			
1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	
1	1	1	2	2	3	reduce the accuracy of inputs for elements under your control?
1	1	1	2	2	3	reduce the extent to which you were able to control your elements?
2	3	3	1	0	1	reduce the timeliness of inputs for your elements?
2	1	3	1	2	1	overload the center controller during peak periods?

[a]Frequency of responses from controllers at forward company console.

[b]Frequency of responses from controllers at fire support console.

[c]Frequency of responses from controllers at aggressor console.

52. What, if any, procedures had been established to insure that the center controller made accurate and complete command and control inputs for all three controllers at a console? Would you recommend the establishment of such procedures? If so, describe your recommendations. (N=7)

--- Two respondents (1B, 1R) indicated that there was no need for established procedures applicable to all consoles.
--- Two respondents indicated that should be established SOPs as a general guideline (1B, 1R).
--- Other responses consisted of either recommended procedures or descriptions of procedures at a console: "close coordination necessary" (1B), "doublecheck center controller" (1B, 1A), "query controllers at a console in rotation and write down their inputs desired by them" (1B).

53. Did you have tactical plans that you attempted to follow consistently for each of the Attack, GOLD, and SILVER? Yes 6 No 4

If yes, describe any factors that interfered with your executing your plans. (N=5)

--- None (2B, 1R).
--- Mine fields in ATTACK and SILVER (1B).
--- Suppression (1B).
--- Player's orders (1B).
--- Controller fatigue (1B).
--- Controller interaction (1B).

54. During training exercises, did you ever deviate from the math model by providing players information that either conflicted with or was not included in math model outputs? Yes 6 No 1

If yes, answer the following questions:

a. What types of information did you transmit to players that conflicted with computer outputs? List the types of information. (N=6)

--- Smoke and other types of ammunition (1B).
--- Information about damage (1B).
--- Reasons for delays (1A).
--- Minefield breachings and losses (1B).
--- Visual detections (1B).
--- Enemy intelligence (1B).

b. What types of information did you communicate that were not included in computer outputs? List them. (N=6)

--- Smoke and other types of ammunition (2B).
--- Engineer activities (1B).
--- Burning MTGs (1B).
--- Information about adjacent units (1R).
--- Items to enhance realism (panic,,excitement) (2B).

c. Did you experience any difficulty in integrating the conflicting or added information with subsequent information provided by the computer and appropriate for transmission to players? Yes 3 No 3

If yes, describe the difficulties. (N=4)

--- Weather was changed to provide smoke. The changed weather conditions affected everything on the battlefield (1B).
--- I was caught in a lie almost every time someone made something up (1A).
--- I had to catch up with my lies to avoid presenting a misleading picture later (1B).

55. a. Did you play more than one military role at the same time during an exercise? Yes 9 No 2

b. If yes to a above, did the requirement to play multiple roles reduce your capacity to perform the job requirements of any of them? Yes 3 No 6

c. If yes to b above, indicate which roles were affected and the manner in which your performance was degraded. (N=3)

--- Delayed responses to players (1A).
--- Experienced difficulty playing the commanders of four units at once (1B).
--- Required unrealistic switches of attention (1B).
--- Role of Bde S2/S3 interfered with telephone switchboard operations (1R).

56. Could the training during system definition research have been conducted with fewer controllers? Yes ✓* No 11
(* "But not adequately").

If yes, how many controllers would be required? What would be their assignments?

No response.

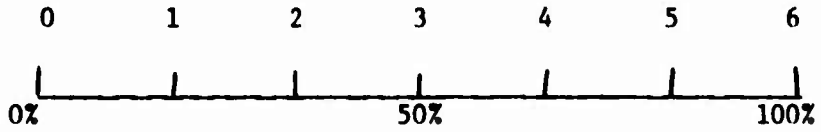
57. Did you have a system for taking notes on information provided by the computer? Yes 8 No 3

Identify changes in the HW/SW that would reduce the requirements to take notes. (N=4)

--- Print messages on A/N CRT (1R).

58. In your opinion, was there a need for an established procedure such that if a controller failed to attend to an important alert on the A/N CRT, another controller would notify him: Yes 4 No 6

59. How confident are you that you were able to accurately and continuously track those opposing units that were in contact with your units? Select your response by placing an X over a number on the scale below.



N=10
range = 4.5 - 6.0
mean = 5.0

What computer outputs did you use to identify initial contact? (N=9)

--- Nine (5B, 3R, 1A) respondents indicated that they used alert messages. One of these noted the use of engagement alerts (1B).
--- One respondent (B) noted the use of the "proximity" of units.
--- One respondent (R) indicated the sound of gun fire (presumably aural detection alerts).

What computer outputs were used to track the contact? (N=9)

--- Information on A/N CRT (5B, 3R, 1A).
--- Graphics (2B, 2R).

What types of outputs would aid you in identifying and tracking enemy contact? (N=3)

--- None (2B, 3R).
--- Ability to query computer to identify activities of a unit (1A).
--- Displayed information about line of sight (1B).
--- Alert messages/graphics (1B).

60. Were you ever surprised to learn that your units were suppressed by opposing forces? Yes 6 No 3

61. Graphic symbols do not differ for full-strength and attrited units. Did this lack of differentiation create difficulties?
Yes 7 No 5

62. In your opinion, did players receive the proper types and amounts of information upon which to base their decisions?
Yes 12 No 0

63. In your opinion, was the execution of calls for artillery support realistically accurate? Yes 11 No 0

64. Did the exercise provide players an adequate opportunity to engage in intelligence gathering activities? Yes 12 No 0

65. In your opinion, was the execution of calls for air support realistically accurate? Yes 11 No 0

66. If one of your units were receiving fire from a ground element of the opposing force, what computer outputs did you use to determine which enemy unit was engaging your unit? (N=9)

--- Alert messages (5B, 2R).
--- Special status reports (1B, 1A).
--- Graphics (1B, 2R).

67. What computer outputs did you use to determine the damage that your weapons/units were inflicting on the opposing forces? (N=9)

--- Special status reports (5B, 3R, 1A).
--- Alert messages (4B, 3R).
--- Controller coordination (1R).

68. What impact, if any, did the military competence of a player group have on efforts required by you to control a training exercise? (N=9)

--- Number indicating little to no impact: 4.
--- Number indicating significant or much impact: 5.
--- Representative comments:
"Military competence of a battalion in combat requires different degrees of effort from company commander" (1B).
"Affected amount of command and control required" (1R).

69. From a player's point of view, in what ways does a CATTS training exercise differ from a regular CPX with a well planned scenario? (N=10)

--- More realistic (2B, 3R).
--- Faster pace (1B, 1R, 2A).
--- Pressure on player groups (2B, 1R).
--- Realtime (1B, 1R).
--- Execution rather than planning oriented (2B, 1A).
--- Requires commands to be executed ASAP (1B).
--- Greater use of artillery and air (1B).
--- More realistic casualty rates (1B, 1R).
--- Requires commander to integrate all his combat assets in realtime under realistic pressures and rewards him for the proper use of those assets (1B).
--- It provides a post-exercise review/analysis that is intellectually appealing (1B, 1R).

70. What was the greatest difficulty that you experienced in performing your duties as a controller? (N=9)

--- Self-maintenance problems:
- lack of lunch breaks (1B, 1A).
- keeping up to speed (2B, 1A).

--- Personnel/management problems (3B).

--- Work areas:
- competition for access to command and control input devices between artillery and air support (1B).
- getting units to move once they were suppressed (1R).
- computer failures (1R).
- moving brigade and adjacent units during heat of battle (1R).
- adjacent play (1B).
- switchboard operation (1R).
- participation in this research (1B).

71. In your opinion, what is the most important change that should be made in the present CATTS system? (N=10)

--- Improve weapons effects (2B, 1R, 2A).
--- Add other types of artillery ammunition (1B).
--- Improve effects of air strikes (1R).
--- Add smoke (1R).
--- Improve terrain interactions (1B, 1R).
--- Alter model so that interactions of units are not calculated from center of mass only (1R).
--- Start using CATTS to train and to study what a battalion command group needs to learn to do (1B).
--- Improve management of CATTS (1B).

APPENDIX D

PLAYERS' DECISIONS

Players' Decisions: Observation Procedures

GENERAL APPROACH

For four training exercises, the performances of each of two controllers serving as forward team commanders were independently observed by a researcher to collect data related to decisions made by players during the exercises. The observations focused on two interrelated categories of data. The first category pertained to (1) the decisions communicated by the player battalion commander (CO) and operations officer (S3) during the execution phase of an exercise and (2) the responses of the forward team commanders (controllers) to these decisions. The second category concerned one means by which the controller could implement a player's decision. This means, referred to as "command and control inputs", involved making inputs to the computer so that the decision would be at least partially enacted through (or taken into account by) the math model. To collect the two categories of data, an observer had to attend to both the activities of the controller and the communications of the controller with the player CO and S3. The communications were also tape recorded for a later analysis of their content.

PROCEDURAL GUIDELINES

In monitoring the communications and observing a controller's performances, the observer was to adhere to the following procedural guidelines:

1. Monitor the issuance of the battalion operation order in order to become familiarized with the future plans/actions of the controller being observed in his role as company/team commander.

2. Observe the following for the controller as he enacts that role.

a. The general performances of and unfolding tactical situation of the controller.

b. The communications of this controller, especially with the player Bn CO and S3.

c. Command and control inputs made by the controller occupying the center console position.

3. If the controller being observed as the forward company/team controller occupies an end position, the following procedures are prescribed:

a. Monitor the radio and telephone nets to identify and record data about decisions communicated to the controller by the player CO and/or S3. As used here, a decision is defined as an expression of an intention that actions be taken or that some objective, purpose, or mission be achieved. Assign a number to each decision identified; this number will be used to reference the decision in later data-collection procedures. Each decision communicated by the player CO and S3 is to be assessed in terms of the controller's performances and the tactical situation in order to make and record judgments on the decision observation form (see page 174) about the variables defined in the next sub-paragraphs.

(1) game time: the game time in minutes in which the decision was communicated to the controller.

(2) initiator of communication: the person by role (that is, player or controller) who initiated the communication in which the decision was transmitted to the controller.

(3) role of the player: as referenced by the call sign, the position of the player (that is, CO or S3) that communicated the decision.

(4) summary of decision: a brief description of what the player directed the controller to do or to achieve.

(5) action implications of the decision: whether actions are required to implement the intent of the decision in the context of the tactical situation. A decision has no action implications when no change in the actions of the controller (or his units) is required to implement the intent of the decision. Examples are decisions in which the player directs the controller to continue his current actions, announces that no decision will be made at this time, etc. A decision has immediate action implications if the tactical situation is such that the controller needs to initiate an action to accomplish the intent of the decision. A decision has contingent or future action implications if the decision directs future actions or if the controller would need to initiate actions depending on the conditions that develop in the tactical situation. If the decision conveys more than one intent, the decision may have more than one action implication.

(6) controller's response to the decision: those performances that occur after receipt of the decision and that appear to be linked to (or result from) the decision. The controller makes no response when in the interval succeeding receipt of the decision, the controller does not appear to initiate actions by either communicating with another controller or directing a command and control input. Record commo w/controller if the controller communicates to and requests another controller to take present or future actions with respect to the intent of the decision. Note that all communications with a controller regarding actions responsive to the decision are to be placed in this category except for communications with the controller at the center console position that direct him to take actions through command and control inputs. Record C & C input if the controller communicates a request to the controller occupying the center console position to make one or more command and control input. Note that depending on the decision and the controller's subsequent actions, both commo w/controller and C & C input may be checked.

b. Record data about command and control inputs made for units under the authority of the controller as forward company/team commander.

(1) monitor the command and control inputs made by the controller occupying the center console position to identify those inputs made for units under the authority of the controller being

observed as forward company/team commander. At least two sets of indicators are available for identifying these inputs. The first consists of communications to the center controller in which the forward company/team controller requests a command and control input. The second involves the selections made by the controller in making a command and control input. That is, except for the weather option, the controller making the command and control input will designate which blue unit is to be affected by the command and control input. It will be assumed that if a unit selected in a command and control input is under the responsibility of the controller being observed, the command and control input is relevant for observation.

(2) for each command and control input made for units of the forward company/team controller, record the following information:

(a) game time (previous definition).

(b) reference number: the number referencing a decision of a player as described earlier in paragraph 3a. If the command and control input was not based on a communication instigated by a player's decision, this item will remain blank. If the command and control input was based on a decision of the player, the reference number of the decision is to be recorded to indicate the decision to which the command and control input was in response.

(c) source: the originator of an input for units under the authority of the controller being observed. If the input were made by the center controller (operator of input mechanisms)

and if the observed forward team controller did not request the input, check own. Thus, own is to be checked to indicate that the command and control input operator made a command and control input for units under the command of the observed controller without the latter having directed the input. Check controller/player if a communication from the observed controller had directed the input operator to make the input.

(d) indicate which command and control input was made by checking task organization, control measure, maneuver, fire control, resupply, weather, etc.

(e) if the controller directed more than one command and control input in response to a player, each ensuing command and control input would have the same reference number.

4. If the controller being observed as forward company/team controller occupies the center position, the procedures are identical to those prescribed in paragraph 3 with one exception. Since this controller is the input operator, own is to be checked for all command and control inputs made for units under his authority. A reference number will indicate that a decision was in response to the decision of a player.

Players' Decisions:
Observation Form

COMMUNICATED DECISIONS

Game Time _____

Initiator Player _____ Player Role Bn CO _____

Controller _____ Bn S3 _____

Summary of Decision _____

_____

Action Implications No _____

Immediate _____

Contingent/Future _____

Controller Response No _____

Commo w/Controller _____

C&C Input _____ (Ref. No. ____)

****

COMMAND & CONTROL INPUTS

Game Time _____ Reference No. _____

Source Own _____

Controller/Player _____

Intent Maneuver _____ Task Organ _____

Fire Control _____ Control Meas _____

Unit Location _____ Resupply _____

Activate Units _____ Air Defense _____

Weather _____

Players' Decisions: Procedures for Analysis of Player's Decisions and Feedback

GENERAL APPROACH

For four training exercises, two controllers performing as forward team commanders were observed. The purpose was to collect data on (1) decisions communicated to the controllers by the player CO and S3 and (2) the controllers' responses to the decisions. During the exercises, communications between the controllers and players were also tape recorded. The tape recorded communications along with the original observations were later jointly analyzed by two researchers who had served as data collectors during the exercises. The two analysts reviewed the recorded communications and observation data in order to make consensual judgements about the following:

1. the decisions communicated to the controller (in the appropriate role) by the player CO and S3.

2. variables related to the conditions prompting the decision.

3. variables related to the implementation of the decision through command and control inputs.

4. feedback to players' decisions, defined as information about the implementation of a decision that was communicated by the controller to the players' tactical operations center (TOC).

A researcher who had not participated as an observer during the exercises next reviewed the summaries of the decisions and feedback

identified by the first two analysts. The third reviewer's disagreements with the summaries were resolved between the third reviewer and one of the original two analysts.

PROCEDURAL GUIDELINES

The following procedural definitions and rules guided the analysts in judging the tape-recorded communications:

1. Review the tape-recorded communications between a forward company controller and the player CO and S3 in conjunction with the decision-making observation forms (see the earlier section of this appendix). Each decision communicated from the TOC to the forward company controller is to be identified. For each decision, judgements about the data listed on the "decision content analysis form" (see page 183) and defined in subsequent paragraphs are to be made. In reviewing a tape, follow these general guidelines.

a. Identify decisions on the basis of the recorded communications. That is, do not restrict analysis to the decisions identified while directly observing the exercises.

b. If a decision recorded on an observation form is not found on the appropriate tape recording, mark <u>not identified</u> on the back of the observation form on which the decision was recorded during the exercise.

c. Data are to be recorded about feedback. As used here, <u>feedback</u> consists of information communicated by the controller to the TOC about the implementation of a decision. If feedback to a decision were communicated, it would be found in communications

subsequent to the one transmitting a decision. Accordingly, it will be necessary to track communications through time in order to identify and analyze feedback. To accomplish the latter, one of two approaches may be taken. First, a tape would be reviewed until a decision is identified. All subsequent communications (i.e., the remainder of the tape) would then be reviewed to identify feedback to that decision. This process would be repeated for each successive decision. This first approach is probably the most desirable in terms of thoroughness and accuracy. However, it would be time consuming. According to the second approach, the communications on a tape would be reviewed in order. As each decision is identified, it would be recorded. Each successive communication would then need to be analyzed in terms of its relevance as feedback to any preceding decision as well as in terms of whether it conveys a decision. This second approach, thus, would possibly require the analysis of communications for feedback to an increasing number of decisions through time. Either approach may be adopted in analyzing the communications.

2. As used here, a decision is an expression of an intention that actions be taken or that some objective, purpose, or mission be achieved. For each decision identified on a tape, record the following data:

a. Game time (item no. 1)[1] - the game time in minutes in which the communication transmitting the decision was initiated, as recorded by the person recording the communications.

---

[1]The item number in parentheses is the item number on the content analysis form.

b. Summary of decision (item no. 2) - a brief description of the decision communicated to the forward company controller. The summary is to be complete enough that it would be intelligible to someone who was not familiar with the actual communication.

c. Identification of decision (item no. 3) - a decision identified during the content analysis had also been identified during the exercise if the decision was referenced and recorded on a decision observation form.

(1) To determine this, it will be necessary to refer to the decision observation forms and to compare the game times and summaries of the decisions on the observation forms with the communications being reviewed.

(2) If the decision had been identified during the exercise, record the decision number from the observation form.

d. Implementation of decision (item no. 4) - based on the observation form, whether the decision had been implemented through command and control inputs.

(1) Record yes or no for decisions that were identified during the exercise (item no. 3) depending on whether the observation form indicates that one or more command and control inputs had or had not been made by the controller in response to the decision. Record N/A if the decision had not been identified during the exercise.

(2) If no or N/A is the appropriate response, determine whether the decision could have been implemented through command and control inputs. A decision could have been implemented through command and control inputs if two conditions are met. First, the decision was such that it had positive action implications. The decision had positive action implications if depending on the tactical situation, actions would have been required to implement it. Second, command and control inputs can be identified through which at least some of the action implications of the decision could be implemented.

(a) record yes if both conditions just described are met.

(b) record no if one or both of the conditions are not met.

(c) record don't know if the information contained on the tape or your knowledge about command and control inputs does not allow you to determine whether one or both of the conditions are met.

e. Conditions prompting decision (item no. 5) - the manner in which information transmitted to players by the controller instigated or led to the decision.

(1) Direct response: The decision was made in direct response if, first, there is evidence that the players had received information about conditions or a problem in the immediate tactical situation and, second, the decision represents a direct response to the conditions. Examples are as follows:

(a) a controller requests permission to take a certain action because of certain conditions, and the players indicate that he may (or may not) do it.

(b) a controller reports the loss of resources (men/materials) that reduces his combat effectiveness, and the players order him to assume a reserve status.

(2) General response: The decision is to be classified as a general response if it represents a player's response to general or long-term developments in the tactical situation that may or may not have been reported to the players. Examples are as follows:

(a) players order the heavy mortar platoon (combat trains, CP, etc) to relocate to maintain appropriate distance between that unit and the maneuver elements.

(b) players direct a controller to report information regarding certain types of activities (e.g., crossing a phase line, enemy activity around an obstacle).

(3) Unknown - classify the decision as unknown if the instigating conditions cannot be identified.

f. Direct response (item no. 6) - if the decision was made in direct response, additional judgements are to be made. First, indicate whether the forward company controller (whose communications are being analyzed) had provided information regarding the conditions that instigated the decision. If the response is yes, identify and record the number of separate communications in

which that controller had provided information to the players regarding the conditions. For this item, a communication is defined as a radio or telephone transmission between the controller and one or more participants in CATTS. Indicate the game time of the communication in which the conditions, which the decision was in response to, were first mentioned.

g. Feedback (item no. 7) - as defined earlier, any information regarding the implementation of a decision. For each decision, identify communications in which controllers provided feedback to players. Summarize the feedback by communication. That is, for each communication, describe, first, the game time at which the communication was initiated and, second, the major topics or subjects that were communicated as feedback. Describe the topics in sufficient detail so that someone not having reviewed the tape would be able to understand what feedback the player had received. For each topic in a communication, make two additional judgements. First, determine whether the player requested the feedback or whether the feedback was automatically provided. The feedback was requested if the player requested information and the feedback was provided in response to the information request. The feedback was provided automatically if the controller provided the feedback without the player's having requested information. Place R or A after the summary of a topic to indicate whether the feedback was requested or automatic, respectively. Second, in terms of your knowledge of computer outputs, judge whether the feedback

could have been based on one or more computer outputs. For each topic, record yes if you believe that the feedback could have been based on a computer output; otherwise, record no.

Players' Decisions: Form
for Content Analysis

1. Game Time _____

2. Summary of Decision _____

_____

_____ _____

3. Decision identified during the exercise: Yes _____ no _____

If yes, indicate the decision number _____

4. Decision implemented through command and control inputs?

Yes _____ no _____ N/A _____

If no or N/A, could the decision be implemented through command and control inputs? Yes _____ no _____ don't know _____

5. Conditions that prompted decision

_____direct response

_____general response

_____unknown

6. If direct response is selected,

a. Information from forward company controller communicated?

Yes _____ no _____

b. Number of communications _____

e. Game time of first communication _____

7. Feedback

SUMMARY OF DECISIONS AND FEEDBACK[2]

Defense 1: [3] Left Position

Decision

In response to the results of a RED air strike, the TOC directed the team commander to move his unit to its alternate positions (0348).

Feedback

R---The team commander reported the status of his unit's movement to its alternate positions (0357).

Decision

The TOC ordered the team commander to move his unit to an earlier designated position as soon as possible (0437).

Feedback

A---The team commander reported progress in moving to the designated position (three occasions---0439, 0446, and 0448).

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[2]The numbers in parentheses at the end of a decision or feedback represents the game time at which the decision/feedback was communicated. The letters R and A preceding feedback denote whether the feedback was requested or provided automatically, as defined in the content-analysis procedures for players' decisions.

[3]Defense - 1 was started at a game time of 0300 and ended at approximately 0510

Defense 1: Right Position

Decision

The TOC advised the team commander that the enemy knew the location of his team trains and recommended that the trains be moved (0349).

Feedback

None.

Decision

The TOC directed the team commander to move to his alternate positions and to notify the TOC when the change had been completed (0354).

Feedback

None.

Decision

The team commander reported that he intended to turn his unit around to engage RED elements crossing the canal. The TOC directed the team commander to disregard the RED elements and to move to his alternate positions (0403).

Feedback

None.

Defense 1: Right position cont'd

Decision

Subsequent to a corresponding warning order, the TOC directed the team commander to cross attach his tank platoon to another team (0406).

Feedback

None.

Decision

The TOC directed the team commander to move his unit to a new defense line along a designated grid line (0414).

Feedback

None.

Decision

The TOC ordered the team commander to engage the RED unit by fire from his present location and not to move forward (0438).

Feedback

None.

Decision

The TOC ordered the team commander to withdraw to new positions along a designated grid line and to tie-in with an adjacent team (0456).

Feedback

None.

Defense 1: Right position cont'd

Decision

The TOC ordered the team commander to move to a new position at a designated center of mass (0500).

Feedback

None.

Decision

The TOC ordered the team commander to disengage and move to a designated bridage blocking position (0508).

Feedback

None.

Attack 1:[4] Left Position

Decision

After having made several reports of the locations and activities of RED forces, the team commander reported that forces in his team were going to advance against the RED forces. In response, the TOC ordered the team commander to hold and not advance until a BLUE air strike had been effected (0637).

Feedback

None.

Decision

The TOC advised the team commander that because of a change in the RED situation, his forces were to disengage and follow another BLUE unit in zone. The team commander was requested to report to the TOC when he had made this change (0641).

Feedback

R---Upon its request, the TOC learned that the team commander would encounter no difficulty in disengaging his units (0644).

Decision

The TOC ordered the team commander to move to the South and to assume the mission of another unit (0649).

Feedback

R---After having requested the information, the TOC learned that the team commander was moving to assume the mission of the other BLUE unit (0655).
R---Upon request, the TOC was provided information about the team's location (0700).

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[4]Attack - 1 was started at a game time of 0500 and was terminated at approximately 0755.

Decision

The TOC warned the team commander that depending on developments in the situation, he would continue the attack by either leading or following one of the other attacking teams (0656).

Feedback

None.

Decision

The TOC ordered the team commander to advance and halt at a designated phase line and not to become engaged with opposing RED units (0708).

Feedback

None.

Decision

The TOC ordered the team commander to attack the objective in his new zone (0717).

Feedback

None.

Decision

The TOC ordered the team commander to halt his advance on the objective along a designated grid line to allow another BLUE unit to attack the objective (0719).

Feedback

R---Upon request for the information, the TOC was informed that the team commander was 300 meters from the designated grid line (0723).

Attack 1: Left position cont'd

Decision

The TOC shifted priority of fires to the team commander in preparation for his attack on the opposing forces (0725).

Feedback

None.

Decision

The TOC ordered the team commander to attack the objective (0732).

Feedback

A---The team commander reported consolidating the objective (0742).

Attack 1: Center Position

Decision

The team commander informed the TOC of heavy casualties and requested a decision from the task force commander regarding continuation of the attack. The TOC directed that the team commander was not to proceed further against the opposing forces and that the opposing forces would be countered by either supporting fires or another unit (0620).

Feedback

A---The team commander advised that the relieving unit should approach his sector from the southeast, as opposed to the south, in order to avoid running into a RED mechanized element (0629).

Decision

The team commander reported that the RED forces to his front were withdrawing and requested permission to resume movement forward. The TOC approved proceeding with the attack and requested that the team commander keep the TOC informed on his situation (0630).

Feedback

A---The team commander advised the TOC that since he had only one tank and a mechanized unit, his advancement would progress very slowly (0632).

Decision

The team commander advised the TOC that since he had only one tank and a mechanized unit, his advancement would progress very slowly. The TOC revised its earlier order (0630). It directed the team commander that another unit would assume his mission and that he should attach his remaining elements to the relieving unit (0632).

Feedback

A---The team commander advised that he had received additional tracks and that the location of the approaching relieving unit was observed (0643).

Decision

The TOC advised the team commander that a new unit would enter the attack and would assume the center zone (0710).

Feedback

None.

Decision

The TOC directed the team commander to be prepared to receive a platoon of tanks and then to join the attacking echelon (0734).

Feedback

None.

Decision

The TOC ordered the team commander to halt at a designated phase line and to hold there until directed to resume advancement (0735).

Feedback

None.

Decision

The TOC ordered the team commander to become the task force reserve and to follow another unit until needed (0737).

Feedback

None.

Defense 2:[5] Left Position

Decision

The TOC directed the team commander to send (to attach) one of his CSR teams to another forward team (0358).

Feedback

None.

Decision

The team commander reported heavy casualties due to attacking RED units crossing a canal (note---in the scenario, the canal was an international boundary). The team commander concluded that his forces would not be able to stop the advance of the RED units across the canal and that his forces would have to pull back relatively soon. The TOC directed the team commander to continue the defense from his present positions (0405).

Feedback

A---The team commander reported that he had lost a couple vehicles due to the RED attack and that two or three RED vehicles had crossed the canal onto the BLUE side. He pointed out that his fires had not been able to stop the RED advance (0408).

Decision

The TOC order the team commander to shift to the alternate radio frequency due to RED jamming (0412).

Feedback

None.

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[5]Defense - 2 was started at a game time of 0300 and terminated at approximately 0538.

Defense 2: Left position cont'd

Decision

The team commander reported that his northern element had lost a tank and 10-15 personnel and that two or three RED APCs had crossed the canal. In response, the TOC directed the team commander to continue to hold his position (0414).

Feedback

A---The team commander reported that his unit was in "big trouble". He indicated that he would not be able to hold the RED forces and that he needed to pull back (0416).

Decision

The TOC ordered the team commander to withdraw to a designated position and to defend during his withdrawal (0421).

Feedback

A---The team commander reported that he was attempting to break contact and that he doubted his ability to get out (0422).
A---The team commander reported progress in his withdrawal to the new defensive position (6 reports from 0425-0444).
A---The team commander reported arrival at his new defensive position (0444).

Decision

The TOC directed the team commander to withdraw one kilometer to the rear of his present position (0445).

Feedback

A---The team commander reported progress in moving toward the new position (0451).

Defense 2: Left position cont'd

Decision

The TOC directed the team commander to advance his unit forward, assume the mission of another team, and establish the defense along a designated line (0452).

Feedback

A---The team commander reported that his tanks were moving to the new defense location (0502).
A---The team commander reported progress of his tanks in moving toward the new location (0508).
A---The team commander reported RED activities encountered in approaching the new location (0510).

Decision

The TOC ordered the team commander to withdraw to a designated point. In doing so, the mechanized units were not to be moved (0518).

Feedback

A---The team commander reported the loss of all of his mechanized units. He also indicated that he would likely have difficulty in withdrawing to the designated point (0521).

Decision

The TOC directed the team commander to prepare to have his mission assumed by another unit (0522).

Feedback

None.

Defense 2: Right Position

Decision

On several occasions, the team commander had reported personnel and equipment losses due to RED artillery and air strikes. After having inquired and learned that fire was being returned, the TOC directed the team commander to continue returning fire and to keep the TOC informed (0347).

Feedback

A---The team commander reported that his units were still receiving artillery and air strikes. The TOC informed the team commander of future air assistance and obtained target descriptions (0348).

Decision

The team commander requested recommendations in the light of the continuing receipt of heavy artillery fires and casualties in his weapons platoon. The TOC informed the commander of future artillery and air assistance. It directed the team commander to continue his present mission (0350).

Feedback

A---The team commander reported that his weapons platoon had sustained so many casualties that he could not continue to perform his mission (0352).
A---The team commander reported that his weapons platoon had sustained so many casualties that he could not continue to perform his mission (0354).

Decision

The TOC ordered the team commander to move to a new defense position (0501).

Feedback

R---The team commander reported having reached his new location (0520).

Defense 2: Right position cont'd

Decision

The TOC directed the team commander to withdraw to a designated location and to form a defensive front (C521).

Feedback

A---The team commander reported moving (like a son-of-a-bitch) toward the new location (0523).
A---The team commander reported that his unit was moving and trying to withdraw to the new location (0525).

Decision

The TOC issued a warning order to the team commander such that he was to be prepared to have his mission assumed by another unit (0523).

Feedback

None.

Decision

The TOC directed the team commander to move his unit to a new location (0531).

Feedback

A---The team commander reported problems encountered while moving to the new location (0537).

Attack 2:[6] Left Position

Decision

The TOC directed that supporting fires would be shifted to assist the team commander since his attack had been stalled by RED artillery and air strikes (0553).

Feedback

R---Upon request, the team commander informed the TOC that the effectiveness of RED artillery fires had been attenuated since supporting fires had been shifted (0555).

Decision

The team commander requested air support to counter RED units along a designated grid line. The TOC indicated that it would place air support on the RED units right away (0603).

Feedback

R---The team commander provided specific target information requested by the TOC at 0607 (0609).
A---The team commander inquired about the delivery of the air strike. He interrupted his inquiry to report that the air strike was being delivered at that time (0613).
A---The team commander reported that no damage had resulted from the air strike (0617).

Decision

The team commander reported that his unit was stalled and needed support. He indicated that if his unit were to advance from its present location, it would suffer heavy casualties because of opposing anti-tank guns. The team commander requested a decision from the commander as to whether he should move his unit. The TOC directed the team commander to attempt to by-pass the resistance by maneuvering to the north (0619).

Feedback

None.

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[6]Attack - 2 was started at a game time of 0500 and terminated at approximately 0825.

Attack 2: Left position cont'd

Decision

The TOC ordered all team commanders to by-pass any opposing element and to seize the battalion objectives (0647).

Feedback

A---The team commander reported by-passing a RED element (0702).

Decision

The team commander reported that his unit was opposed by a RED company and that his 1st Platoon had lost all of its tanks. The reserve company was ordered to assume the mission of the team commander (0719).

Feedback

A---The team commander reported further loses. The TOC indicated that the reserve company was advancing to relieve his unit and assume its mission (0720).
R---The reserve commander reported progress (0723).

Attack 2: Right Position

Decision

The team commander requested supporting artillery fires (including suppressing fires) to counter a RED company with ten tanks that was attacking his position. The TOC responded that it would get "something" on the RED forces right away (0602).

Feedback

None.

Decision

The team commander reported that his unit had received a RED air strike and that the REDEYE section had not returned fire. The TOC directed the team commander to investigate why the REDEYE section had not returned fire (0609).

Feedback

None.

Decision

The TOC denied a request of the team commander to leave his designated axis of advance to gain maneuver room (0619).

Feedback

None.

Attack 2: Right position cont'd

Decision

The team commander requested permission to employ his mechanized unit on a screening mission to support his attack. The TOC denied the request because air support would soon be delivered (0626).

Feedback

None.

Decision

The team commander reported that his 1st Platoon had been wiped out. He requested direct support from the platoon currently on a screening mission. The TOC approved the request (0632).

Feedback

None.

Decision

The TOC ordered all team commanders to by-pass any opposing element and to seize the battalion objectives (0647).

Feedback

A---The team commander reported by-passing a RED element (0703).

Decision

Because RED units were located in that direction, the TOC denied the request of the team commander to by-pass to the north. Instead, it directed the team commander to swing to the south (0735).

Feedback

A---The team commander reported progress in its maneuver to the south (three reports at 0741, 0743, and 0745).

Attack 2: Right position cont'd

Decision

The TOC ordered the attacking team commander to by-pass RED elements and to seize its objective (0800).

Feedback

Decision

The TOC ordered the reserve commander to by-pass the company attacking to the south and to seize the objective (0813).

Feedback

A---The reserve commander reported progress as his unit advanced toward the objective (0819).